Agriculture Sector Write-Up for Public Distribution
AB 32 Scoping Plan

Introductory Information

Sector Background

1) The location and/or geographic extent of the sector as it would pertain to the Plan

Agriculture is spread throughout California with world-wide competition. There are approximately 76,000 farms in California, covering a total of 26.3 million acres.[1] Agriculture is concentrated in the Central Valley, but there is also a significant agricultural activity in other regions. The top five counties in 2006 value of production were Fresno, Tulare, Monterey, Kern, and Merced counties, with Stanislaus, San Joaquin, Ventura, San Diego, and Imperial counties rounding out the top ten.[2]

2) Unique considerations or issues with sector

The agriculture sector is unique in that nearly 82 percent of all greenhouse gas (GHG) emissions from the sector involve biological processes. Sources which do not involve biological systems are energy use/fuel combustion and agricultural burning. These sources account for approximately 5 million metric tons carbon dioxide ($MMTCO_2E$) of the total 28 $MMTCO_2E$ emitted by the sector.

The gaps in scientific knowledge and scientific uncertainty in existing data on greenhouse gas emissions resulting from the complex biological process of agro-ecosystems make the identification of real, permanent, additional, verifiable and enforceable reduction measures difficult to immediately implement. Research on understanding these systems, emissions, and rigorous quantification methodologies are needed to achieve the full reduction potential from this sector.

Because of the complex nature of the biological functioning of agro-ecosystems, emission reduction projects can often result in multiple co-benefits. Co-benefits include reductions in criteria and toxic pollutants; reduced impacts on soil, water, groundwater and watershed quality; reduced chemical inputs to soil, agro-ecosystem functioning, soil quality, erosion control and habitat and viewshed enhancement; improved animal health, animal productivity; increased use of renewable fuel sources and reduced dependence on energy imports.

Sector Overview

[1] California State Agriculture Overview – 2006. United States Department of Agriculture National Agricultural Statistics Service.
http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_CA.pdf
[2] "California Agricultural Resource Directory 2007. California Department of Food and Agriculture. http://www.cdfa.ca.gov/Statistics.html

3) Proposed emission reduction pathway for the sector

Due to scientific uncertainty resulting from complex biological process of agro-ecosystems, traditional command and control regulations may not be feasible for many of the identified measures. In addition, implementation of many measures may not be cost effective without providing additional incentives or establishing an offset market.

4) The potential for leakage from the sector

Any measures resulting in a decrease in production such as loss of planted acreage or reduced yields could result in increasing imports from other states and countries.

5) Role of local, state, and federal government

Agriculture is regulated by multiple state agencies including the State and Regional Water Boards, Air Resources Board, Local Air Pollution Control Districts, Integrated Waste Management Board, Department of Pesticide Regulation, Office of Environmental Health Hazard Assessment, Department of Food and Agriculture, and others. The authority to enforce measures identified for agriculture depends on the measure under consideration. Often, multiple agencies may have enforcement authority over different aspects of the same project. For example, the installation and operation of digesters have cross-media impacts and must be assessed by multiple agencies including the Air Resources Board, Local Air Districts, Regional Water Boards and potentially the Integrated Waste Management Board (CIWMB). In addition, if digester gas is injected into the pipeline, they are also subject to requirements under California Energy Commission (CEC) and Public Utilities Commission.

There needs to be a concerted effort among regulatory agencies to address cross-media impacts and the time-consuming approach and sometimes conflicting requirements of the regulatory permitting processes. The largest complaint from stakeholders who are being proactive and attempting to implement projects is that the media-specific environmental assessments needed for various agency permits are sometimes conflicting and does not allow for consideration of net environmental benefits of a project.

Because the identified measures fit within a voluntary reduction framework encouraged through incentives or a potential offset market, enforcement of measures would occur through third party verification of reductions.

6) Public-private interface

There is no public-private interface to address.

7) Interaction with other sectors

Each of the identified greenhouse gas reduction strategies in the agriculture sector shares links with one or more other sectors.

Agricultural operations include opportunities for efficiency improvements in water use and the fuel needed to run irrigation pumps. Improved water pump efficiency in conjunction with implementation of best practices for water management has impacts on both water and fuel use and can result in reductions greenhouse gas emissions.

The utilization of agricultural biomass as a feedstock, fuel or energy production has implications for many sectors including the electricity, transportation, oil and gas/refining, manufacturing and waste management/recycling sectors. For example, use of agricultural biomass would contribute to meeting the goals of the renewable portfolio standard. Increases in transportation emissions may result from transporting agricultural residues that would otherwise be utilized on farm to a biomass facility.

Utilization of dedicated biofuel crops could contribute to meeting the renewable fuels standard impacting the oil and gas/refining sector as well as the transportation sector. Expanding the use of dedicated biofuel crops can also result in increased inputs such as water, fertilizer and pesticides. Increasing inputs may lead to increased fuel usage both on farm and in manufacturing processes. Conversion of non-agricultural and existing farm land to biofuel crops has implications for the land use sector and may drive up food prices by reducing the supply of agricultural products used for food, feed, and fiber.

Methods to improve fertilizer use efficiency can have upstream impacts on the emissions associated with the production of synthetic fertilizers.

Agricultural composting can result in increased waste diversion from landfills and use of the material can result in reduced on farm inputs including water and fertilizers. Reductions in fertilizer use can also yield up stream emission reductions associated with fertilizer production.

Carbon sequestration measures including riparian restoration and tree planting, soil carbon sequestration, and farmscape sequestration have ties to both land use and forestry sectors. Quantification methodologies may be similar to those developed for forestry and there will be a need to insure that lands included under the forest sector are not double counted in the agricultural sector.

Manure management strategies, such as lane flushing, and lagoon and effluent management, have implications for water use and water quality. In addition, strategies involving the capture and use of methane gas for energy or fuel have implications for the electricity sector. Manure used for composting links up with the waste management/recycling sector.

8) Integration with regional, national, or global programs

The reduction measures identified for the agriculture sector should integrate into regional, national or global programs provided accurate location specific scientific data and life cycle analysis is available. One of the issues encountered with many of the agricultural measures including nitrogen fertilizer efficiency and carbon sequestration measures is the availability of site specific data. For example, nitrous oxide emissions are highly dependent on climate, soil type, soil moisture (climate and irrigation), and temperature. Data collected for California conditions may not be applicable to other states or countries.

If a regional, national or global offsets market is established, California farmers and ranchers may be put at a disadvantage in terms of additionality and profitability since California has a much more stringent regulatory framework.

9) Consideration of longer-term goal for 2050

While quantification methodologies are still needed, most reduction strategies identified for the agricultural sector may have the ability to be implemented by 2020 and should continue to provide reductions through 2050. The exception to continued reductions is soil carbon sequestration projects. Activities to increase soil carbon are only effective until the soil reaches its carbon sequestration capacity. Some studies indicate this period is around five years. Continued reductions from this measure would stem from additional farms and ranches implementing soil carbon sequestration activities.

The following two measures have projected longer-term goals for 2050 and beyond:

- **Agricultural Biomass Utilization Measure** – Specific implementation steps and timelines have not been identified at this time. However, the measure proposes that a menu of financial incentives be developed, including increasing Renewables Portfolio Standard goals, establishing incentive and offset programs, and investing in research, development and demonstration projects.
- **Enteric Fermentation Measure** – This measure proposes to reduce GHG emissions of methane via adoption of National Research Council feeding guidelines by 100% of ruminant agriculture by 2050. While specific steps have not been established, the measure proposes providing technical assistance to ruminant agriculture and developing financial incentives for feed manufacturers.

Emission Reduction Strategies

10) Description of the sector's emission reduction approach

All agriculture sector emission reduction approaches are currently envisioned as voluntary actions. Some of the measures such as fertilizer efficiency, tractor tire inflation and agricultural pump efficiency offer win-win strategies that result in both GHG reductions and cost savings for the farmer or rancher. Other measures will most likely require some mechanism, such as an offset program or incentives, to make projects economically attractive. Many of the measures are dependent on obtaining scientific data to support the development of accurate and rigorous quantification protocols which would ensure the reductions achieved are real, permanent, additional, verifiable and enforceable.

Because some identified measures may fit best within a voluntary reduction framework encouraged through incentives or a potential offset market, enforcement of measures would occur through third party verification of reductions.

The Agricultural Tractor Tire Inflation Program is intended to be a voluntary action with participation achieved through education and outreach with the incentive being cost savings associated with implementation. No enforcement mechanism is necessary for this measure.

The following measures and associated co-benefits should achieve feasible reductions with a goal of 100 percent implementation by 2020:

- Agricultural Pump Efficiency Program; co-benefit of reductions in criteria and toxic pollutants resulting from reduced diesel combustion and potential water-saving opportunities.
- Agricultural Tractor Tire Inflation Program; co-benefit of reductions in criteria and toxic pollutants resulting from reduced diesel combustion and reduced N2O emissions from soils resulting from soil compaction.

The following measures need additional research and quantification methodologies developed. It is anticipated these measures could achieve 100 percent implementation by 2020 if deemed feasible.

- Manure Management; co-benefit of improved animal health and living conditions, lessened impacts on groundwater, improved nuisance control (flies, odor), potential source of renewable energy
- Fertilizer Use Efficiency; co-benefit of reduced nitrate, nitrite and ammonium in water, and reduced emissions from fertilizer manufacturing
- Farmscape Sequestration; co-benefits of erosion control, reduced use of pesticides, increased wildlife habitat and corridors for wildlife, viewshed
- Soil Carbon Sequestration; co-benefits of improved agro-ecosystem functioning, reduced dust from tillage, reduced fugitive dust (PM) from fields, reduced water table pollution by excessive use of chemical fertilizers

- Riparian Restoration and Tree Planting on Agricultural Lands; co-benefits of erosion control, reduction of sedimentation of watersheds, improved water quality (riparian buffering of nutrient inputs to rivers), wildlife habitat, viewshed
- Dedicated Biofuel Crops; co-benefits of increased use of renewable fuel sources, reduced dependence on energy imports, reduced fugitive dust emissions from land that might otherwise lie fallow, improved soil quality.
- The Enteric Fermentation measure is anticipated to be 50% completed by 2020 and 100% achieved by 2050. Co-benefits of increased feed efficiency and product quality, improved animal health.
- The Agricultural Biomass Utilization measure is anticipated to be completed by 2050; co-benefits include providing a needed outlet for accumulated agricultural biomass due to the mandated phase out of agricultural burning. Increased use of biomass can expand the use of renewable energy, and reduce petroleum dependency.

11) How were emission reduction measures developed or evaluated?

The measures were identified by the Agriculture Climate Action Team Subgroup and were evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email.

Measures moved forward if they showed potential for real, feasible and quantifiable emissions reductions that could be realized with limited additional research. In addition, associated co-benefits and support for existing regulations were also considered.

Cost effectiveness is not known for many of the agricultural sector measures. Once research exists to determine the measures' potential emission reductions, cost effectiveness can be determined.

12) Ensuring real, permanent, quantifiable, verifiable, and enforceable reductions

Because many of the measures identified would be voluntary, protocols would need to be developed to ensure that the reductions achieved are real, permanent, quantifiable, verifiable and enforceable. The California Climate Action Registry (CCAR) has established protocols for GHG accounting for the instillation and operation of manure digesters. Research is needed for other measures to allow for rigorous quantification protocols. Verification would occur through third party verification.

Regulatory control measures to achieve anticipated emission reductions could be explored and developed, as warranted. For example, statutory mandates to increase biomass utilization capacity such as setting future production targets for

biofuels or generating capacity for electricity from biomass, could shift industry and financial resources to meet those objectives.

13) Existing controls resulting in emission reductions and co-benefits

No control measures have been implemented solely for reducing GHG emissions from the agricultural sector. However, existing control measures for criteria and toxic pollutants may also provide greenhouse gas emission reductions.

14) Early Action Measures, Discrete Early Action Measures, Climate Action Team (CAT) Early Action Measures

ARB Early Action Measures

- Board adoption of the CCAR Livestock Protocol for GHG accounting from the instillation and operation of manure digesters
- Collaborative research to understand how to reduce emissions from nitrogen land application

CAT Early Action Measures

- Manure management through use of biogas digesters along with the production of electricity and/or heating applications
- Conservation tillage/cover crops (soil sequestration)
- Enteric Fermentation

15) Public Solicitation Measures

The early action measure for collaborative research to understand how to reduce emissions from nitrogen land application was submitted by stakeholders during the early action solicitation period. In addition, the composting measure was added based on stakeholder input at the Agriculture Work Group meetings.

We anticipate the public will provide further comments and data when the sector scoping plan measures are disseminated. We will consider and evaluate all public input on the measures. We especially seek to solicit relevant agricultural research feedback concerning the measures and will evaluate and, as warranted, incorporate this input as we refine the Scoping Plan.

16) Expected reductions from the overall sector approach

The table below shows the preliminary estimated reductions achievable from the identified measures. These estimates may need to be refined as more data from research becomes available.

	AgCAT Estimate: Max Feasible Annual Reduction **at 100%** Implementation MMTCO2E	AgCAT Staff Estimate: Feasible Reductions for **2020** MMTCO2E	Notes
Ag Pump Efficiency	0.2	0.2	@ 5% efficiency improvement target
Tractor Tire Inflation	0.1	0.1	Estimate based on average fuel savings of 3 crops and 3 primary tillage operations applied to statewide acreage
Manure-to-Energy Facilities	1.0	1.0	100% implementation by 2020. • Issues to be addressed include permitting, infrastructure, rates
Fertilizer Use Efficiency	1.0	1.0	ARB Research Division estimate
Agricultural Biomass Utilization	2.3	0.6	25% implementation by 2020, 100% by 2050 AgCAT – adjusted: approx. 44% from manure = 0.6 in 2020 • Issues to be addressed include permitting, infrastructure, contracts, and biomass transport
Dedicated Biofuel Crops	1.0	1.0	• Issues to be addressed include environmental impacts, effects on inputs, food/feed costs
Soil Carbon Sequestration	1.0	1.0	50% Implementation by 2020 AgCAT – primarily from continued cover cropping • Issues to be addressed include: permanence of carbon, California soil sequestration potentials, lifecycle analysis and potential N2O emissions
Farmscape Sequestration	1.5	0.5	25% implementation by 2020 and 50% by 2050 • Issues to be addressed include sequestration potential farmscape species
Enteric Fermentation	0.2	0.1	50% implementation by 2020 AgCAT - 53% reductions from National Research Council feeding recommendations (many already using, assume half are not: leaving 26%), 36.6% from agents/additives (development of 20+ years) and 3% long term breeding
TOTALS*	**9.1**	**6.3**	***Assuming ability to quantify reductions**

17) Public health effects—Effects on air quality

It is anticipated that most of the proposed emission reduction measures for the agricultural sector will also reduce criteria pollutants such as NOx, ammonia, volatile organic compounds (VOCs), and particulate matter (PM) PM_{10} and $PM_{2.5}$.

The operation of engines use for digesters and additional biomass facilities may increase air emissions and require mitigation.

18) Environmental justice impacts

It was determined that for many measures, there would be no environmental justice impacts. However, the Dedicated Biofuel Crop measure could negatively impact environmental justice communities if food prices rose due to replacement of traditional crops with biofuel crops. Similarly, the Enteric Fermentation measure could negatively impact environmental justice communities if the prices of milk and beef rose due to greater costs to feed ruminant agriculture. Increased toxic and criteria pollutant emissions from new biomass facilities could potentially have an impact on environmental justice communities.

While the identified measures were presented to stakeholders as part of the AB 32 Agriculture Sector Work Group, targeted input from environmental justice communities has not been a specific effort thus far. Impacts to environmental justice communities will be considered and input solicited when issues are identified that relate to specific implementation projects, such as siting biofuel and biomass utilization facilities.

Summary and Conclusions

Agriculture is vital to California's economic strength providing many jobs and income to the State. Warmer temperatures related to climate change are anticipated to have significant negative impacts on California agriculture resulting in higher operating costs and economic losses.

One of the obstacles to realizing reductions from agriculture is that each of the measures shares links with one or more other sectors, adding significant complexity to the scientific knowledge necessary for ensuring that measures that categorically yield greenhouse gas benefits do not result in unintended consequences. Research is needed to develop rigorous quantification methodologies and ensure reductions achieved are real, permanent, quantifiable, verifiable and enforceable and do not result in other unintended impacts.

Another obstacle to realizing reductions from agriculture is ensuring multi-media impacts are addressed. Agriculture is regulated by multiple state agencies with enforcement authority over different aspects of the same project type. In addition, to implement the measures, regulatory agencies must make a concerted effort to address cross-media impacts and the time-consuming approach and sometimes conflicting requirements of the regulatory permitting processes.

Agricultural sector measures are anticipated to realize multiple co-benefits including reductions in criteria and toxic pollutants; reduced impacts on soil, water, groundwater and watershed quality; reduced chemical inputs to soil, agro-ecosystem functioning, soil quality, erosion control and habitat and viewshed enhancement; improved animal health, animal productivity; increased use of renewable fuel sources and reduced dependence on energy imports.

The agriculture sector is important and complex. As we move forward with greenhouse gas reduction strategies for the sector we must make every effort to ensure that actions taken do not result in unintended consequences for the farm or rancher, the environment, or the economy.

Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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Outline

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Carbon Sequestration in Agricultural Soils

2. AgCATAgencies:

California Department of Food and Agriculture, California Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. Measure Description

This measure calls for research to address large uncertainties regarding the amount of carbon (C) being sequestered by the proposed management practices, the increased nitrous oxide (N_2O) emissions that often accompany soil C sequestration, and the permanence of sequestered carbon in the soil. Research is also needed to establish practical means to measure soil carbon to verify C sequestration and assess the overall greenhouse gas (GHG) mitigation effects of sequestration projects.

Overview

Increasing the stocks of organic carbon in soils through the adoption of alternative management practices is often presented as a way to remove large amounts of carbon dioxide (CO_2) from the atmosphere. An upcoming Public Interest Energy Research (PIER) report (Six and Howitt, 2007) reviewed long term experiments to assess the GHG mitigation potential of conservation tillage, cover-cropping and manure application in California and estimated that the effect of each of these management option is modest (e.g. 0.1 to 0.2 tonne of CO_2e per acre per year for conservation tillage), and that only combinations of these options yielded more substantial reductions.

Estimates for potential GHG mitigation activities on California's 41 million acres of rangelands have not been evaluated, as data about the mitigation benefits of alternate management techniques are lacking for these types of land.

Many uncertainties remain to be cleared up before we can develop protocols that would allow farmers to adequately quantify potential reductions achieved through practices aimed at sequestrating carbon in soils.

Below is a summary of recent findings and relevant questions, mostly from the upcoming PIER report on the potential of GHG mitigation in California agricultural soils (Six and Howitt, 2007), unless otherwise noted:

- *Data on orchards and vineyards are lacking.* There are virtually no data to validate biogeochemical models of orchards and vineyards GHG emissions and sinks. Research is needed to assess these perennial crops that are an important component of California agriculture (2,000,000 acres of orchards and 800,000 acres of vineyards in 2005).

- *Rice is a special case.* Rice is the only main California crop associated with significant methane (CH_4) emissions. Rice was not well simulated by Six and Hewitt (2007) because the DAYCENT model does not simulate flooding. It is likely that regulations to reduce burning of rice straw in the field induced the adoption of practices (winter flooding and incorporation of straw in the soil) that have greatly increased CH_4 emissions (Fitzgerald et al., 2000). In general, the use of crop residue as an alternative fuel works against the soil carbon sequestration potential for the fields from which residue was exported. But in the case of rice, using the crop residues as fuel may be a good way to achieve GHG mitigation. Research is needed to clarify the best methods for reducing rice GHG emissions. About 525,000 acres of rice were harvested in 2005 in California.
- *Promoting soil carbon sequestration may actually increase agriculture's GHG emissions.* It is imperative to consider the impact of alternate management practices on soil emissions of N_2O and CH_4 and not just on stocks of soil organic carbon. Soils with higher C content often have higher N2O emissions, both across the landscape and within a field. Six et al. (2004) compiled all available data of soil-derived GHG emissions comparisons between conventional tillage and no-till systems. They found that a shift from conventional to no-till produced no reductions in radiative-forcing for the first 10 years because increased N_2O emissions more than cancelled out the gains from the sequestered carbon (in CO_2 equivalent). Similarly, Li et al. (2005) did a series of biogeochemical model simulations to evaluate the impact of different management strategies (reduced tillage, enhanced crop residue incorporation and manure application). They found that, over 20 years, increases in N_2O emissions offset 75% to 310% of the carbon sequestered in CO_2 equivalent.
- *The impact of a particular management option is difficult to predict because it is the result of complex biological and ecological processes.* Six and Howitt (2007) used long term experiments to parameterize a biogeochemical model to assess the effects of conservation tillage (no-till is not practical in California), cover-cropping (growth of a crop in winter that will be used as a soil amendment), and manure application. They found that the effects on GHG emissions of combinations of these management practices are not always additive. For instance, conservation tillage + cover crop had about the same effect as cover crop alone, but conservation tillage + manure had much greater effect than either practice alone. The effect of combinations of management options were crop dependent (e.g. winter cover crop + manure decreased GHG emissions for tomato crops but increased emissions for safflower). And since crops are grown in rotations, potential reductions should be calculated per crop rotation. The potential for emissions reduction of a particular management technique also depended on soil characteristics, amount of fertilization, water management, and other factors. Importantly, the potential for emissions reduction depended on the region, most likely due to climate. For instance, simulated emission reductions were consistently lower in the San Joaquin Valley than in the Sacramento Valley.
- *The capacity of soils to sequester carbon is limited and temporary.* Depending on soil characteristics, a new steady-state in soil organic carbon content may be reached in 20-25 years of applying a particular management option. After that, continuation of the management is necessary just to maintain the soil carbon store without new gains in C sequestration. What is gained over many years can be lost in just a few years through the oxidation of soil organic carbon back to atmospheric CO_2 (e.g. a return to conventional tillage practices). Once a steady state is reached, an additional and complementary management option may yet cause another temporary increase in soil organic carbon content, but all soils eventually reach a saturation level (West and Six,

2007). A better understanding of C saturation levels for soils could contribute to more accurate estimates of C sequestration rates and duration following changes in land management.

- *Assessment of soil management techniques should also include changes in direct energy use.* Changes in GHG emissions from agricultural machinery fuel use associated with the management options discussed above are not clear at this point. Reduced tillage may result in a reduction of 0.07 Mg CO_2 eq. ha^{-1} $year^{-1}$ (according to a USDA website). But cover cropping should involve an increase in fuel use for planting and mowing/chopping it, and fuel for transport of manure or compost to the field and for spreading it should be evaluated.
- *Measurement and monitoring costs are a problem.* The best would be to monitor N_2O (and CH_4 in some cases) as well as C sequestration. However, methods to directly measure GHG emissions and sinks in the field are prohibitively expensive. With enough data specific to California's soils, crop rotations, and alternate management options, biogeochemical models could be used to provide a valid assessment of the average effect of these options on GHG mitigation. Methods to measure the amount of carbon being sequestered in soils are more affordable, but probably still too expensive. Some argue that, until a practical means of verifying emissions is established, C sequestration programs should be based on payments for the adoption of the management practices themselves (e.g. reduced tillage). But, how to verify the application of these practices over the landscape is itself an open question. For the reasons discussed above, a carbon credit program based simply on adopting a management practice would be counterproductive unless research and subsequent modeling offer credible assessments of how much GHG mitigation is achieved by the adoption of the particular practice, for a specific crop rotation, in specified soils types, and for how long.

Reducing N_2O emissions from soil is more promising than sequestering carbon. Permanent decrease in the contribution of agriculture to global warming is achieved by avoiding soil N_2O emissions. These emissions are a factor of soil characteristics, weather, irrigation practices, etc. However, N_2O emissions generally decrease with the amount of nitrates freely available in the soil. For instance:

- A consistent decrease of N_2O emissions of about 0.5 Mg CO_2 eq. ha^{-1} $year^{-1}$ was simulated by Six and Howitt (2007) when manure is applied *instead* of chemical fertilizer (if there is no over fertilization).
- A 25% decrease in nitrogen fertilizer application when compared to recommended practices could lead to reductions in N_2O emissions of 0.5 to 0.8 Mg CO_2 eq. ha^{-1} $year^{-1}$ with limited effects on yields.

In the scoping plan, measures to reduce nitrogen fertilizer use and substitute organic forms of fertilizer (such as manure or compost) should be developed in concert with measures to increase soil carbon sequestration.

Affected Entities

This measure will affect agricultural land owners that have an interest in alternate soil management practices such as reduced tillage (or conservation tillage), cover-cropping, manure or compost amendments.

Environmental Justice, Small Business, Public Health, Leakage and California Environmental Quality Act (CEQA)

Stakeholder comments

This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email.

Environment justice issues

This measure does not interfere with public health efforts such as achieving and maintaining federal and State air quality standards and reducing toxic emissions. There may be a benefit from reductions in fugitive dust and improved water quality.

Small Business Impact

No adverse impact is anticipated. Adoption of new management techniques will require farmers to purchase new implements for reduced tillage, mowing or chopping cover-crops and to spread manure. This may benefit some small businesses.

CEQA issues

No issues are foreseen.

Related Objectives

Adoption of the alternative practices would improve agro-ecosystem functioning and may reduce some environmental impacts of agriculture such as dust from tillage, water table pollution by excessive use of chemical fertilizers. Better and more widespread use of manure on soils may reduce the negative impacts associated with the current concentration of liquid manure in lagoons.

Measure Metrics

No metrics have been identified at this point.

Measure Goals and Potential Implementation Approaches

Goals in terms of GHG mitigation are very uncertain at this point. Many uncertainties must be resolved to allow for the development of potential quantification methodologies.

Research is needed to reduce uncertainties related to the quantification of GHG emissions and potential emission reductions including life cycle analysis for soil carbon sequestration activities.

- Incentive Programs: A federal conservation program could be used as a complementary incentive to the adoption of land management techniques if research provides a sound foundation for soil carbon sequestration protocols.
- Offsets Program: Protocols for soil carbon sequestration projects cannot be developed without further research.
- Research: Research should focus on providing the following:
  - A better understanding of the processes responsible for N_2O emissions, as these emissions may more than offset the GHG mitigation gains achieved through soil C sequestration.
  - Enough experimental data to parameterize biogeochemical models to assess the GHG mitigation of soil management options for California's specific circumstances: climate, crop rotations, soil types, irrigation methods, etc. Data are particularly lacking in the case of perennial crops (orchards and vineyards) that are an important component of

California's agriculture. Special attention should be given to alternate rice cultivation techniques, as flooding brings specific soil conditions responsible for significant CH_4 emissions.

- A better understanding of C saturation levels for California soils. This would lead to more accurate estimates of C sequestration rates and of the duration of the sequestration following changes in land management.
- Including fossil energy use in calculation of the GHG mitigation impact of soil management techniques.
- Practical and cost effective methods of measurement for monitoring and verifying to eventually support protocol development.

4. Technology

New technologies may be useful to implement this measure. In particular, technologies for measuring soil carbon and GHG emissions - see for instance Post et al. (2001) and Gehl and Rice (2007).

5. Statutory Status

No statutory modifications are needed to implement this measure.

6. Implementation Steps and Timeline

To be determined.

7. Greenhouse Gas Emission Reductions

More information needed.

8. Costs and Cost Savings

More information needed.

9. Other Benefits

See "related objectives" above. Special studies would have to be conducted to be more specific.

10. References

ETAAC, 2008. Recommendation of the Economic and Technology Advancement and Advisory Committee (ETAAC) on Technologies and Policies to Consider for Reducing Greenhouse Gas Emissions in California. February 14, 2008.

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Climate Action Team
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Scoping Plan Measure Development and Cost Analysis

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Agricultural Biomass Utilization

AgCAT Agencies: California Department of Food and Agriculture, Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

2. Measure Description

This measure explores the potential for using agricultural biomass to increase the use of renewable energy sources and reduce greenhouse gas (GHG) emissions. Biomass can be utilized for electricity generation, as a renewable fuel such as ethanol, biodiesel, biomethane and hydrogen, and as feedstock for products such as plastics, solvents, inks and construction materials. This is not a regulatory measure. It is an attempt to identify the potential benefits of increasing agricultural biomass utilization and actions needed to promote its use.

Overview

Biomass in California is a largely untapped resource. The California Biomass Collaborative has estimated that California generates nearly 83 million bone-dry tons of biomass annually from agriculture, forestry and municipal sources. Not all of this resource is available for utilization due to agronomic and ecological requirements, terrain limitation and political constraints. While an estimated 31 million tons of biomass are technically available for utilization, currently only about 5 million tons are used each year. The total energy contained in the biomass now considered to be available for utilization in California exceeds 500 trillion British thermal units (Btu) per year or roughly 6 percent of California's primary energy demand[1].

Agriculture generates nearly 21 million bone dry tons of biomass every year with half coming from prunings, crop residues, and food and fiber processing wastes and half from animal manures. Roughly 8 million tons of this biomass is technically available for sustainable energy and fuels production. Currently, only 1.1 million tons are currently utilized by biopower facilities.

Biomass utilization for energy or fuel production can play a significant role in reducing GHG emission reductions while providing a number of other benefits including providing a needed outlet for accumulated agricultural biomass due to the mandated phase-out of agricultural burning. Developing alternative uses for biomass would complement regulatory programs requiring farmers to reduce open burning of residues. For example, approximately 1.1 million

[1] California Biomass Collaborative, *A Roadmap for the Development of Biomass in California*, California Energy Commission Contract 500-2006-095-D, Sacramento, CA, November 2006

tons of rice straw is produced annually, with over 95 percent available from the Sacramento Valley. In 1991, a law requiring the phase-down of rice straw burning was passed. This spurred the industry to manage rice straw though intensive non-burning alternatives that cost the California rice industry approximately $16-$18 million each year. Other commodity providers in the San Joaquin Valley are facing the same regulatory pressure to reduce or eliminate open field burning. These regions are ideal for investment in a conversion facility capable of using rice straw or other locally-produced biomass. Such investment could contribute significantly to AB 32 objectives and address the economic burden experienced by rice growers and other farmers complying with burning phase-down legislation.

The extent of future utilization of available biomass in California will depend on many factors including State policies, available technologies, and market forces to facilitate the technical and economic changes needed to realize the reduction potential from biomass utilization.

- Improve efficiencies at existing biomass facilities
- Investment to prove advanced bio-chemical and thermo-chemical technologies on commercial scale
- Regulatory hurdles; CIWMB regulations are designed for solid waste facilities
- Development of state policies for sustainable management of biomass and development of biomass utilization technologies
- Design and implement performance-based standards and best management practices for environmental quality, health and safety, fuels and products
- Develop improved harvest systems for agricultural residues
- Optimize logistics for feedstock harvest, transport, preparation/processing and storage
- Conduct life-cycle assessment of biomass and bioenergy systems to account for impacts and benefits from utilizing in-state resources as well as imported biomass
- Assess environmental justice issues for future resource development
- Improve factors used for agricultural residue estimates
- Develop menu of financial incentives to encourage wider adoption of biomass utilization;
    - Carbon taxes on fossil fuels
    - Tax credits for entities producing biomass feedstocks/products
    - Low interest loan and loan guarantee programs
    - Increase Renewable Portfolio Standard goals
    - Develop a carbon credit/offset mechanism
    - Develop long-term contracts that work for both generators and investor owned utilities (IOU's)
    - Expand net metering and apply uniformly across biomass technologies
    - Revise interconnection standards
    - Reinstate direct access
    - Production tax credits

Affected Entities

1) Facilities utilizing biomass as a feedstock or for fuel or energy production.
2) Generators of biomass including agriculture, forestry, and municipal wastes.
3) Communities where existing or new biomass facilities may be located.

Environmental Justice, Small Business, Public Health, Leakage and the California Environmental Quality Act (CEQA)

Stakeholder Comments
This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email.

Environmental Justice Impacts
The impacts on environmental justice communities have not been fully evaluated. Communities may benefit from improved efficiency of existing biomass facilities; however, increased capacities or new facilities may increase existing criteria pollutant emissions. The Biomass Report working group is in the final stages of assessing biomass facility emissions.

Small Business Impacts
It is currently unknown whether this measure would impact small businesses.

CEQA Impacts

There may be environmental impacts requiring mitigation when developing new facility sites.

Related Objectives

The measure is motivated by multiple benefits. Facilitating the expansion of biomass facilities and the use of available biomass will yield reductions in greenhouse gas emissions along with other environmental and social benefits. Increased use of biomass can expand the use of renewable energy, reduce petroleum dependency, and improve environmental quality. This measure;

- Supports Federal Energy Security Act
- Supports Executive Order S-06-06 and the Bioenergy Action Plan related to goals for in-state biomass utilization
- Supports the low carbon fuel standard

Executive Order S-06-06 called for the State to meet the following targets for biofuel and biopower development:

- By 2010, producing 20 percent of its biofuels within California, increasing to 40 percent by 2020 and 75 percent by 2050, and
- By 2010, producing 20 percent of the renewable electricity generated from biomass resources within the State and maintaining this level through 2020.

According to the Biomass Collaborative, statutory mandates to increase capacity such as setting future production targets for biofuels or generating capacity for electricity from biomass, will shift industry and financial resources to meet those objectives. Currently, the renewable portfolio standard (RPS) has not stimulated much biomass development due to competition from lower-cost wind and geothermal resources. As targets are increased, higher cost alternatives will increasingly be selected in order to satisfy the mandate, thereby increasing

prices. This will further stimulate innovation to reduce generation costs. At least over the near term, renewable fuel standards, even if open to any resource type, will provide greater incentives for biomass development due to the limited ability of other renewable resources to provide products.

Measure Metrics

Because no single measure has been identified we are currently only able to estimate the availability and generation potential of biomass resources from agriculture. The metrics used include the technically available bone dry tons on agricultural biomass (including orchard and vineyard prunings, field and seed crop residues, vegetable crop residues, food and fiber processing wastes and animal manures), and the associated power generation potentials (based on assumptions regarding conversion technology, efficiency, capacity factor and individual material properties such as heating value, and biodegradability)[2].

As mentioned previously, the extent of future utilization of available biomass in California will depend on many factors including State policies, available technologies, and market forces to facilitate the technical and economic changes needed to realize the reduction potential from biomass utilization.

Measure Goals and Potential Implementation Approaches

- Mandate Performance: An accelerated Renewable Portfolio Standard such as achieving 33% renewables in the procurement mix by 2020 could help stimulate biomass development in California.
- Incentive Programs: Establishing incentives such as investment credits, low interest loans, or fuel tax credits aimed at encouraging further development of advanced technologies for converting biomass to high value transportation fuels and encourage the development of California's biomass industry.
- Offsets Program: If producers and users of agricultural biomass could get GHG emission reduction credits for utilizing biomass as a renewable energy source, this would serve as another incentive to growers and investors to increase biomass utilization.
- Research, Development and Demonstration: Investment in research to advance biochemical and thermo-chemical technologies.

3. Technology

4. Statutory Status

There are a number of regulatory barriers to effectively implementing this measure. Facilities are regulated under a number of agency jurisdictions including the CIWMB, ARB and local air districts. Currently, the CIWMB regulates gasification and pyrolysis plants converting byproducts under regulations designed for solid waste facilities. Few plans for biomass conversion plants have been approved in recent years as it is estimated to take up to five years

[2] California Biomass Collaborative, *Assessment of Biomass Resources in California*, California Energy Commission Contract 500-01-016, Sacramento, CA, December 2006

to permit and build a thermochemical conversion plat with the current uncertain regulatory process (ETAAC, 2008)

5. Implementation Steps and Timeline

Specific implementation steps and timelines have not been identified at this time.

6. Greenhouse Gas Emission Reductions

Greenhouse Gas Emission Effects:

The potential of biomass utilization to reduce greenhouse gas emissions is significant. However, emission reductions estimates have not been developed due to significant uncertainties about the nature and extent of near-term growth and adoption of biomass management and utilization technologies.

Methodology:

Under contract with the California Energy Commission, the California Biomass Collaborative assessed the availability and generation potential of biomass resources in California. A summary of the methodology used is provided below. The complete methodology can be found in the Biomass Collaborative Report, *An Assessment of Biomass Resources in California.*

Summary
Gross and technical power generation potentials were computed from the resource estimates and assumptions regarding conversion technology, efficiency, capacity factor, and individual material properties such as heating value and biodegradability. Low moisture materials such as wood and some field crop residues were assumed to be converted using thermal technologies, while high moisture materials such as dairy cattle manures, green waste, and food waste were assumed to be converted through anaerobic digestion. In many cases, the conversion efficiencies for thermal and biological systems are similar.

Net thermal conversion efficiencies were assumed to remain constant through 2007 at an average of 20% (based on dry matter higher heating value) and then increase due to improvements in boiler operations or adoption of enhanced technologies such as integrated gasification combined cycles for new capacity additions. Average efficiency was increased to 25% in 2010 and to 30% in 2017 and on. Overall efficiencies in combined heat and power operations were not incorporated into this analysis but economic factors will certainly influence such technology selection in the future with possible ramifications for average net electrical generation efficiency.

Net biological conversion efficiencies were based the biodegradability of the biomass in anaerobic digestion or decomposition and the efficiency of the engine-generator set (genset) or other generator system fueled with the resulting biogas. Genset efficiency was assumed to be 30% for all landfill and digester gas applications. Bioconversion efficiencies were not escalated over time. For the assumptions employed, overall net bioconversion efficiencies range from 13 to 22% based on the higher heating value of total solids.

7. Costs and Cost Savings

Costs associated with production, transport and utilization of biomass resources have not yet been assessed.

8. Other Benefits

Agriculture is only one source of biomass in California. Other significant sources include forestry and municipal wastes. Utilization of these resources could yield an additional 4800 Megawatt electrical (MWe) by 2020, for a statewide total of potential of 6000 MWe by 2020 representing approximately 10 percent of projected statewide peak power capacity.[3]

9. References

California Biomass Collaborative, *A Roadmap for the Development of Biomass in California*, California Energy Commission Contract 500-2006-095-D, Sacramento, CA, November 2006.

California Biomass Collaborative, *Assessment of Biomass Resources in California*, California Energy Commission Contract 500-01-016, Sacramento, CA, December 2006.

Economic and Technology Advancement Advisory Committee Final Report: *Technologies and Policies for Reducing Greenhouse Gas Emissions in California,* February 2008.

[3] California Biomass Collaborative, *An Assessment of Biomass Resources in California*, California Energy Commission Contract 500-01-016, Sacramento, CA, December 2006

Climate Action Team
Agriculture Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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Outline

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Agricultural Equipment Efficiency Improvements- Agricultural Pump Efficiency and Repair Program

2. *AgCAT Agencies:*

California Department of Food and Agriculture, Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. Measure Description

This measure explores the potential for supporting a program to increase on-site testing of agricultural water pumps, provide improvement recommendations, encourage pump efficiency repairs, and promote irrigation scheduling practices. This is not a regulatory measure. It is a potential voluntary action that could be taken if it proves economically feasible that has the potential to further a number of State policy objectives including the reduction of criteria pollutant emissions, greenhouse gas (GHG) emissions and water use.

Overview

The Investor Owned Utilities (IOU's) offer pump test and repair programs to agricultural customers. Farmers have access to the pump test services using local pump test companies in the PGE territory. In the SCE territory customers receive pump test services from both SCE staff and private companies. Both IOU's offer financial incentives to partially cover pump repair costs. Unfortunately these services are not always/consistently available to Publicly Owned Utilities (POU's). If the motor is also found to be inefficient there are funds to replace with high efficiency motors.

If farmers optimize the performance of their water pumps leading to reduction in the number of hours of operation there will be a reduction in electricity demand with commensurate reductions of GHG emissions at the power plant delivering power to the site. If the same measure is accomplished at diesel powered pumps the GHG emissions will be direct from lower emissions from the diesel engine.

Affected Entities

Pump test and repair programs are available to all agricultural customers in the IOU territories, including irrigation districts. The 2003 US Department of Agriculture Farm and Ranch Irrigation Survey (FRIS) stated that there are 83,216 electric or fuel-powered irrigation pumps in California, of which 12,535 (or approximately 14.1 percent) are powered with diesel with the rest being electric driven motors.

Environmental Justice, Small Business, Public Health, Leakage and the California Environmental Quality Act (CEQA)

This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email.

This measure does not interfere with public health efforts. In fact, successful implementation of the measure should reduce toxic and criteria pollutant emissions resulting from diesel fuel combustion.

Related Objectives

The pump test provides a base line of efficiency. If the pumps are running with less than 55 percent efficiency it is recommended the pumps be tuned up, repaired or replaced. Once pump efficiency is improved, the farm has to reduce operating hours to achieve energy savings. To do so, farmers need to adopt scientific irrigation practices by using irrigation scheduling technologies to determine when and how much water to apply to crops. Water savings may also result from this strategy.

This strategy is motivated primarily by non-greenhouse gas benefits. The objective is to improve pump efficiency and reduce hours of operation.

There are no mandates that require the strategy, it is all voluntary.

Measure Metrics

No energy demand savings can be attributed to pump testing alone. After a pump is repaired the following metric was used: Annual kilowatt hours (kWh) were divided by 2000 operating hours per year; with 8% savings assumed for pump repairs.

However, from an irrigator's perspective, a repaired well, booster, or surface water pump provides a range of economic benefits including more reliable irrigation equipment, increased flow rate at design delivery pressures, and shorter irrigation intervals for a fixed volume of water pumped. If the baseline condition and efficiency for a pump system is poor, improvements resulting from the pump system repair generally lead to increases in the motor's electrical demand, flow rate, possibly head pressure, or a combination of the three. With an increase in flow from a pump, an irrigator has choices including increasing the area irrigated by the pump during each irrigation set, reducing the interval over which irrigation of the field takes place, or continuing to operate as before—however, with an increased rate of delivery of water to a field.

When the size of an irrigation set is increased, or the irrigation time decreased, the energy use of a pump should decrease relative to the baseline energy use prior to the pump retrofit and repair. Irrigators who are on voluntary time-of-use rates might be expected to follow through and reduce irrigation times during the highest-cost peak periods of the summer due to high costs of on-peak irrigation. However, if an irrigator fails to shorten the time intervals for the irrigation

schedule, or increases the size of the irrigation set relative to the baseline conditions, the improved pump system may use more energy, despite the improvement in efficiency from pump repairs and retrofits. Even with an improved Operating Plant Efficiency (OPE), if the volume of water delivered increases as a result of the project, overall electrical energy use can increase, resulting in little to perhaps negative average peak period demand savings. An irrigator will have to absorb higher electrical costs, but potential benefits that could outweigh energy savings include an improvement in crop yield, quality, or both from the increased amount of water delivered to a field.

To make a reasonable estimate of energy and demand savings from pump repairs, a critical assumption must be made—an increase in OPE for a pump system allows an irrigator to shorten the time interval or the size of an irrigation set to pump the same volume of water on a seasonal basis to a field, and the irrigator is not going to increase the total volume that is delivered to a field. If an irrigator chooses not to reduce the irrigation schedules, or continues to irrigate with the same set size and schedule, the improvement in pump efficiency will, in many cases, result in increased energy use and peak period demand due to a seasonal increase in water delivery to the field and higher input power requirements to the pump[1].

Any energy or demand savings that might be attributed to the repair of agricultural pumps must be accompanied by a change in the use of the pumping plants. Irrigators have claimed in previous utility-sponsored pump programs that repairs have led to increased energy use[2]. Without changes to the length of irrigation intervals, or in the size of an irrigation set to reflect the new system capacities, overall water delivery tends to increase for a given size field. The increased water delivery is accomplished more efficiently, but nonetheless results in higher overall water and energy use, and increased electrical demand. Changes to system head pressure can also lead to higher pump energy use, even in the absence of an increase in seasonal water delivery to the field.

The calculations for potential demand savings suggest that potentially large savings could be achieved; however, these savings are not likely to occur without additional intervention to insure that additional volumes of water are not applied to a field. Economic incentives from higher crop yields or potentially improved quality are more likely to influence an irrigator's behavior than are increases in utility bills due to slightly higher energy use.

Measure Goals and Potential Implementation Approaches

The goal of this measure is to increase the average pumping plant efficiency by 5% (from 53% to 56%) through pump testing and repair incentives. In addition, education and outreach and development of conservation management practices for agricultural water use will be needed to insure irrigation practices are modified to reflect new system capacity.

4. Technology

Optimal pump testing procedures were developed by CalPoly San Luis Obispo University and Fresno State University. Pump test companies are required to use these protocols to receive

[1] Hanson, Blaine R., "Improving Pumping Plant Efficiency Does not Always Save Energy", California Agriculture, July-August, 2002, 123-127.
[2] Hanson, Blaine R., "Improving Pumping Plant Efficiency Does not Always Save Energy", California Agriculture, July-August, 2002, 123.

payment for pump tests services provided under the auspices of the IOU programs. Pump repairs are also readily available.

The challenge is to establish a target to increase the minimum pumping plant efficiency in agricultural pumps. Based on the Peak Load Reduction Program data, OPE averages 53%.

5. Statutory Status

SB 5x (2001) instructed the CEC to establish a pump test and repair program for the state's agricultural customers. The program established new pump test procedures and offered pump tests and repairs incentives. The program was administered by CalPoly San Luis Obispo University and Fresno State University. After the program funding expired in 2004, Fresno State University continues to offer the pump test and repair program as a third party provider in the PGE territory.

6. Implementation Steps and Timeline

Target: Increase average pumping plant efficiency by 5%, from 53 to 56%, on all agricultural pumps.

Current agricultural water demand: 10,159,900 MWh per year (Source: CalPoly, ITRC Total Agricultural Water Energy Usage in California, 2003)

Target: A 5% pumping plant efficiency improvement will result in 507,995 MWh per year in electricity savings.

To implement a program that reaches this target will require both the IOU's and POU's to consistently test agricultural pumps and aggressively ensure that pump repairs are accomplished. Aggressive education efforts will be needed to get encourage farmers and irrigation districts to meet the target.

7. Greenhouse Gas Emission Reductions

Greenhouse Gas Emission Effects:

The CEC uses a factor of 815 pounds of carbon dioxide (CO2) per MWh consumed. As such, 414,015,925 pounds of CO2 would be removed from the environment if the 5% pumping plant efficiency improvement target was met.

8. Costs and Cost Savings

Costs and Cost Savings:

The pump tests and pump repair programs are already available and partially sponsored by the IOU's through the Public Goods Charge account. Farmers and irrigation districts would have to cost-share 1/3 or so of the total costs.

9. Other Benefits

There is potential water saving opportunities if farmers adopt scientific irrigation scheduling practices.

10. References

[1] Hanson, Blaine R., "Improving Pumping Plant Efficiency Does not Always Save Energy", California Agriculture, July-August, 2002, 123-127.
[2] Hanson, Blaine R., "Improving Pumping Plant Efficiency Does not Always Save Energy", California Agriculture, July-August, 2002, 123.

Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Composting

2. AgCAT Agencies:

California Department of Food and Agriculture, Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. Measure Description

This measure explores the potential for using compost to reduce greenhouse gas (GHG) emissions. This is not a regulatory measure. It is a potential voluntary action that could be implemented to further a number of State policy objectives, provided it is economically feasible. There are a variety of composting systems that have the potential to reduce GHG emissions, but each has significant issues and uncertainties related to implementation costs, handling, fuel and water use, the nutrient content and nutrient availability in the composted material, and quantifying reductions vs. increases in GHG emissions. These must be evaluated to assess the feasibility of various composting options.

Overview

This measure addresses the potential reductions in GHG emissions from wider adoption of composting. Composting is the aerobic, or oxygen-requiring, decomposition of organic materials by microorganisms, primarily bacteria, under controlled conditions. Composting reduces both the volume and mass of the raw materials while transforming them into a valuable soil conditioner. Composting retains most nutrients supplied by the raw materials and stores them within stable organic compounds. Compostable organics make up 30 percent of California's overall waste stream and contribute over 12 million tons annually to the state's landfills.[1] Composting plant waste and/or livestock manure on-farm or at regional facilities is one measure to manage GHG emissions from the agricultural sector.

California has over 200 permitted composting facilities and it is estimated that an equal number of on-farm composting operations exist that are not required to be permitted. While the benefits of composting are real, they are not yet well quantified, because of the number, complexity, and interrelationships among the variables involved.[2] Studies have estimated that composting contributes trivial amounts to GHG inventories, generating only 0.01 – 0.06% of global emissions.[3] Manure management is estimated to contribute approximately 7% to the US agricultural sector's GHG emissions of methane; dairy manure slurry emits 1.9 times more GHG

than compost and stockpiled manure emits 1.5 times more.[4,5] Well-managed composting processes release small amounts of nitrous oxide (N_2O), volatile organic compounds (VOCs) and ammonia, but virtually no methane, compared to the large amounts of methane (CH_4) released during anaerobic degradation of organic matter either naturally or in landfills.[6] Thus, composting reduces GHG by avoiding CH_4 production, compared to stockpiling wastes or disposing of wastes in landfills. Mathematical models, based on the total amount of degradable carbon in various waste types, have been proposed to calculate the methane avoided as a factor of the total amount of degradable organic carbon not disposed in landfills. Models also exist for emission factors from various source materials and various controlled composting processes. One estimate projects that California could reduce its annual GHG emissions by 1 million metric tons carbon dioxide equivalents (MMTCO2E) by composting just 30% of the food waste that is currently disposed of in landfills.[6]

Affected Entities

There are no affected entities associated with this measure other than owners of agricultural and livestock (primarily dairy) operations. However, if composting was widely adopted and the demand for compost processing increased, additional composting facilities may be required.

Environmental Justice, Small Business, Public Health, Leakage and the California Environmental Quality Act (CEQA)

Stakeholder Comments

This measure was identified by the Agriculture Climate Action Team Subgroup and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email. Concerns were raised about removing barriers for new composting facilities, such as regulatory challenges, siting problems, artificially low landfill costs, and the competitive disadvantage for composting.

Environmental Justice Issues

Wider adoption of composting is anticipated to positively impact environmental justice communities. Compared to open dairy manure lagoons, and either natural degradation or stockpiling of agricultural plant waste, composting has the potential to reduce odor and fly nuisance complaints adjacent to farms and dairies.

Small Business Impacts

No adverse impacts on small businesses are anticipated.

CEQA Impacts

VOC, N_2O, and ammonia emissions from composting are not quantified, but are widely considered to be far less than if the materials were stockpiled or degraded in landfills. However, there could be CEQA issues if, after accounting methods are developed, projections indicate that cumulative emissions from composting present greater concerns than currently assumed.

Related Objectives

The measure is motivated by multiple benefits. The composting process and compost use have the potential to achieve these related benefits:

- Diversion of agricultural and municipal organic waste from landfills will assist the regulated community in meeting CIWMB's 50 Percent Diversion Rate (Public Resources Code (PRC) 42921 (b))
- Compost use in school landscaping will assist California schools to meet the goals of CDPR's Healthy Schools Act of 2000 (Assembly Bill 2260) by reducing herbicide use.
- Avoid methane emissions at landfills
- Improve soil fertility and tilth, and increase water retention and soil organic matter, which in turn support sustainable agriculture and reduce N_2O emissions from soil,
- Increase carbon sequestration in biomass and soil and reduce loss of carbon from soil
- Control erosion and improve the quality of ground water aquifers, both of which could be crucial in mitigating the impacts of climate change
- Composting, especially of dairy manure, eliminates odor and thus associated nuisance complaints compared to open lagoons
- Reduce the production and use of commercial fertilizers and pesticides, and achieve reduced energy and water use

Measure Metrics

Metrics will quantify, annually and cumulatively, 1) various adoption and use parameters that indicate greater use of composting technology, and 2) the progress in mitigating GHG emissions from composting vs. non-composted agricultural plant and dairy manure wastes.

Primary Metric - Measuring Adoption of Composting Technology, Annually and Cumulatively:

- Number of agricultural acres treated with compost,
- Tons of agricultural waste diverted from landfills,
- Number of dairies, and herd size, that divert manure from anaerobic lagoons to compost treatment,
- Tons of agricultural compost procured for use by CalTrans and other state agencies and municipalities for use in parks, schools and general landscaping
- Tons of agricultural waste diverted from use in landfills as Alternative Daily Cover to composting.

Measuring Progress, Annually and Cumulatively

- Develop methods to quantify the avoided fugitive GHG emissions from landfills by adopting composting technologies.
- Subsequently, measure the GHG emission reductions from less irrigation, fertilizer and pesticides.
- Develop protocols to quantify climate change mitigation benefits associated with agricultural use of compost.

Measure Goals and Potential Implementation Approaches

Primary Metric - Adopting composting technology, annually and cumulatively.

Measuring Progress:

- Develop methods to quantify the avoided fugitive GHG emissions from landfills by adoption of composting technologies.
- Subsequently, measure the GHG emission reductions from less irrigation, fertilizer and pesticides.
- Develop protocols to quantify climate change mitigation benefits associated with agricultural use of compost.

Potential Implementation Approaches

- State Procurement:
  - Adopt procurement rules that require compost be used in CalTrans' Integrated Vegetation Management and Landscape Architecture Programs.
  - Adopt procurement rules that require compost use as part of the Green Buildings Initiative to increase the efficiency, health and environmental sustainability of state owned and leased buildings.
- Regulatory Actions
  - Assess regulatory barriers to new composting facilities; develop rule-making packages to remove significant barriers.
  - Consider adopting a per-ton GHG emission surcharge on landfill operators to minimize the competitive disadvantage that composting faces.
  - Work with the SJVAPCD and SCAQMD to ensure they consider the net impact of any forthcoming regulations on the composting industry, including biogenic emissions and GHG emission impacts.
  - Phase out the current diversion credit (Alternative Daily Credit) for greenwaste (AB 939).
- Incentive Programs:
  - Provide financial incentives and technical assistance to agricultural operators to adopt on-farm composting and increase their use of compost.
  - If cost-prohibitive mitigation measures for criteria pollutants become required by a regional air pollution control district, the State could offer financial incentives to keep compost operations in business.
- Information Programs:
  - Provide information to the agricultural sector on best management practices for developing a composting program and the use of compost. UC Extension, County Agricultural Commissioners and the California Farm Bureau could play a role in developing and disseminating the information.

4. Technology

The Composting Measure relies on well-established existing technologies; new technologies are not anticipated to be required.

5. Statutory Status

The measure can be adopted with current authority. However, the following implementation approaches, if selected, would require additional statutory authority:

- Adopting a per-ton GHG emission surcharge on landfill operators to minimize the competitive disadvantage that composting faces.
- Phasing out the current diversion credit (Alternative Daily Credit) for greenwaste (AB 939).
- Providing financial incentives and technical assistance to agricultural operators to adopt on-farm composting and increase the use of compost.
- Offering State funded financial incentives to keep compost operations in business if cost-prohibitive mitigation measures for criteria pollutants become required by a regional air pollution control district.

6. Implementation Steps and Timeline

Implementation Steps

1. Compile and/or develop technical guidance and related resources for adopting agricultural composting, such as best management practice guides for on-farm composting, directory of composting facilities, record-keeping forms, etc.

2. Assess regulatory barriers to new composting facilities

3. Conduct outreach activities with the agricultural sector to describe the measure, the desired metrics, and disseminate resource materials.

4. Based on stakeholder feedback during outreach activities, assess the need for financial incentives.

5. Develop rule-making packages to remove significant barriers and establish any necessary financial incentive programs.

6. Develop a reporting system and tracking database for capturing compost adoption metrics

7. Develop methods to quantify the avoided fugitive GHG emissions from landfills by adoption of composting technologies.

8. Using the measurement, reporting and tracking tools outlined in items 6 - 7, develop estimates of avoided fugitive GHG emissions from landfills by greater adoption of composting technologies

9. Develop a database or other capture mechanism to track trends in agricultural use of water, fertilizer and pesticides for adopters of composting technologies; integrate the database with the reporting system in item 3.

10. Measure and track the GHG emission reductions from less irrigation, fertilizer and pesticides

11. Develop and implement protocols to quantify climate change mitigation benefits associated with agricultural use of compost:

7. Greenhouse Gas Emission Reductions

Greenhouse Gas Emission Effects:

The reductions in GHG emissions by adopting composting technologies are real, but no tool currently exists to estimate anticipated reductions. Developing methods for quantifying GHG emissions for composting is a critical component of developing and implementing this measure.

8. Costs and Cost Savings

Studies indicate that composting operations for a dairy can easily amount to $100,000 per year.[7] Research also indicates that, assuming a minimum of 100,000 throughput tons per year, capital costs can range form $40 - $700 per ton.[8]

However, because no model exists for calculating the reductions in GHG emissions for composting, it is not currently possible to estimate costs or cost savings. Instead this section presents some of the presumed inputs necessary to adopt composting and discusses potential avenues for cost offsets or reductions.

9. References

1. California Air Resources Board. *Final Report: Recommendations of the Economic and Technology Advancement Advisory Committee*. Feb. 11, 2008.

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

The purpose of this document is to provide the public with information about options considered and analyzed by the Climate Action Team (CAT) Sector Sub Groups for Air Board's consideration and potential inclusion in the Scoping Plan. This information should be drawn from the Measure Analyses previously developed by each Sub Group.

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Outline

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Dedicated Biofuel Crops

2. AgCAT Agencies:

California Department of Food and Agriculture, Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. Measure Description

This measure explores the potential for using dedicated biofuel crops for the production of fuels as a means to increase the use of renewable energy sources and reduce GHG emissions. This is not a regulatory measure. It is a potential voluntary action that could be taken if it proves economically feasible that has the potential to further a number of State policy objectives. There are a variety of cereals and oilseed crops that could serve as dedicated biofuel crops, but each has issues related to energy balance, water consumption and increased food costs that must be evaluated to assess the feasibility of dedicated biofuel crops in California.

Overview

Crops grown primarily for use of energy feedstocks or the production of fuels, rather than for food or fiber, are referred to as dedicated biofuel crops. There are several types of potential biofuel crops that California farmers might produce profitably. These include certain cereals, oilseeds, and sugar crops. If 500,000 acres could be available in the near term for starch, sugar, or oil crops for producing biofuels, there is the potential for 1 MMTCO2E per year (Economic and Technology Advancement Advisory Committee, (ETAAC), 2008).

Forages, grasses, woody crops, food processing wastes, and straw also have potential for production as biofuels but they are addressed in separate measures as part of biomass from forest and agricultural waste products. Because of the state's long growing season, high-quality soils, and potential available acreage, a wide array of biofuel corps and strategies may prove feasible. In some cases, water and the need for agronomic inputs may be a constraint, but there are some areas where biofuel crop production can be important in managing ground water regimes.

Potential crops and strategies require systematic assessment based on available data, as well as research on plant genetics and plant improvement through biotechnology to optimize biofuel crops to California conditions. Field trials for selected species and novel cultivars with significant potential will be needed because there are little data available for California conditions. Results need to be used in simulation models to estimate the magnitude of effects on such factors as food security, farm income, water use, land use, and GHG effects.

Affected Entities

There are no affected entities associated with this measure other than growers, businesses, or organizations that participate. However, local water or irrigation districts could be affected if production of biofuel crops significantly increased water demand.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

Stakeholder Comments

This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email. Concerns raised about this measure centered around effects on water quality and water availability as well as potential impacts on food and feed prices. Positives related to this measure are increased farm income, winter cover crops, and reduced erosion on marginal lands.

Environmental Justice Issues

The major environmental justice issue would be the potential impact on food prices due to the replacement of traditional crops with biofuel crops.

Small Business Impacts

No adverse impacts on small businesses are anticipated.

California Environmental Quality Act (CEQA) Impacts

If significant amounts of new land are brought into production or if there are water quality issues related to large-scale production of biofuel crops, there could be CEQA issues that need to be considered with this measure.

Related Objectives

- Supports Federal Energy Security Act
- Promotion of biofuel crops supports Executive Order S-06-06 and the Bioenergy Action Plan related to goals for in-state biofuel production
- Supports low carbon fuel standard
- Biofuel crops used as fall or winter crops could reduce fugitive dust emissions from agricultural lands.
- Some types of biofuel crops may able to grow using saline water or salt-affected land that is not feasible for growing traditional crops.
- Some winter biofuel crops have show potential to extract selenium and other salts from soils.
- Some commodity crops in California are suffering from declining markets and biofuel crops offer California growers new alternatives for crop rotations.

Measure Metrics

Metrics for this measure relate to cultivation of biofuel crops and the production of fuels. Both of these metrics presuppose the availability of the infrastructure and processing plants to convert the biofuel crops to biofuels.

Barrels of Oil Equivalents

This metric relates to the number of barrels of biofuel or equivalent in barrels of oil. The 1 million metric tons carbon dioxide equivalents (MMTCO2E) assumed for biofuels is equivalent to 2.6 million barrels of oil equivalent of biofuels.

Number of Acres Under Cultivation with Biofuel Crops

This metric would assess the acreage devoted to cultivation of biofuel crops by crop type. The 1MMTCO2E assumed for biofuels would devote approximately 500,000 acres to biofuel crops.

Measure Goals and Potential Implementation Approaches

The goal for this measure would be to plant 500,000 acres of biofuel crops in California by the year 2020. This would also include the development of infrastructure and processing plants capable of handling the biofuel crops. This would result in annual production of approximately 2.6 million barrels of oil equivalent by 2020.

Implementation of this measure will be dependent on incentives and the potential for saleable credits to provide growers with incentives, and provide a comfort level to potential investors in biofuel processing plants.

- Incentive Programs: Subsidies are already used for corn-to-ethanol projects. Similar approaches should be explored for other types of biofuel crops. There are also tax incentives that could be explored for producers of biofuel crops and/or investors in biofuel processing facilities
- Offsets Program: If producers of biofuel crops and/or fuels could get GHG emission reduction credits for production of biofuels, this would serve as another incentive to growers and investors to increase production.
- Information Programs: Outreach and information programs should be developed to inform growers about the potential for biofuel crops.
- Research: More research is needed to fully evaluate the overall lifecycle of biofuel crop production. This includes evaluation of water demand, energy balance, impact on food production, agricultural practices, and potential environmental impacts and benefits. The environmental impacts of the facilities necessary to process the biofuel crops into fuels also needs to be carefully reviewed.

4. Technology

There is no special technology involved with this measure because it involves the planting and processing of biofuel crops. The benefit of this measure is to utilize a renewable fuel source to displace fossil fuel emissions.

5. Statutory Status

There are no statutory barriers, but there could be issues related to water quality issues, water contracts, and permitting of biofuel crop processing facilities that could be barriers to the implementation of this measure.

6. Implementation Steps and Timeline

The ETAAC report uses an assumption that 500,000 acres of biofuel crops is feasible by the year 2020. We will need to continue researching this method and working with the agricultural community to achieve a broader consensus on the feasibility of biofuel crops in California.

7. Greenhouse Gas Emission Reductions

- If a goal of 500,000 acres of biofuel crops is achievable by 2020, this would result in approximately 2.6 million barrels of oil equivalent which would displace approximately 1 $MMTCO_2E$ of GHG emissions.
- Life cycle analysis of various biofuel crops shows that overall lifecycle emission from ethanol produced from grains (corn, wheat) can be 10-15% higher than that of fossil fuels. On the other hand, ethanol produced from sugar crops such as sugar beets or sugar cane is 70-80% less than fossil fuels.
- For biodiesels from oil seeds, life-cycle GHG emissions from biodiesel from oil seeds such as rape (canola), or soy result in 25-80% reductions in GHG emissions.
- At this time, there are virtually no dedicated biofuel crops in commercial production in California. Investments in incentives and processing facilities will be necessary to get this effort off of the ground. However, any increase in production would be over and above the current baseline.
- The methodology for the emission estimates used here is contained in the ETAAC report.

8. Costs and Cost Savings

<u>Costs</u>

- The cost of production of biofuel crops varies by the crop and the specific characteristics of the location of production.
- The infrastructure and processing plants necessary to produce the liquid fuels from biofuel crops will be financed primarily by private investment. Initially some form of financial or tax incentives will be needed to help jump start the process. The amount of incentives necessary to get the process rolling is dependent on to many unknowns to be estimated at this time.

9. Other Benefits

Other benefits include increasing the use of renewable fuel sources and reducing our dependence on energy imports. When used as a cover crop, biofuel crops can reduce fugitive dust emissions from land that might otherwise lie fallow. Some biofuel crops can extract salts (such as selenium) from soils and improve soil quality.

10. References

California Air Resources Board. *Final Report: Recommendations of the Economic and Technology Advancement Advisory Committee.* Feb. 11, 2008.
Available at: http://www.arb.ca.gov/cc/etaac/ETAACFinalReport2-11-08.pdf

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Reducing GHG Emissions from Enteric Fermentation

2. Agency:

California Department of Food and Agriculture, Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. Measure Description

This is not a regulatory measure. It is a potential voluntary action that could be implemented to further a number of State policy objectives, provided it is economically feasible. This measure explores the potential for reducing greenhouse gas (GHG) emissions of methane from ruminant agriculture (beef and dairy cows) through utilizing recommended feeding guidelines. For example, cattle receiving low-quality, high-fiber diets produce about four times more methane compared to the same cattle fed a highly digestible, high grain diet.[1]

In addition to achieving emissions reductions by adopting feeding guidelines, other proposed concepts with the potential to significantly reduce enteric fermentation and thus achieve additional reductions in methane emissions have been also identified.[2] The use of agents such as concentrates, oils, ionophores, probiotics and propionate precursors, are aimed at reducing methanogenesis. However, research data for reducing enteric fermentation are sparse and many proposals have significant issues and uncertainties related to animal health, beef and milk production, milk and beef quality, implementation costs, and quantifying reductions in GHG emissions. The effectiveness of these approaches and other impacts must be carefully studied and thoroughly evaluated over at least 20 years. Similarly, reducing enteric fermentation emissions of methane through long term breeding and management changes may serve as a source of reductions, however the contribution would be relatively small. The effectiveness of these practices including quantification methodologies will require more data. These practices may be developed in the future if thorough evaluation indicates they are feasible options to mitigating methane emissions from ruminant agriculture.

Overview

This measure addresses the potential reductions in GHG emissions from dairy cows and beef cattle by implementing feeding guidelines to reduce enteric fermentation of methane. A significant research program focusing on California conditions and diets as specifically related to the avoidance of GHG and reduction of methane emissions is needed to develop new approaches and establish protocols for this technology, while protecting the productivity of the livestock enterprise.[3]

The Economic and Technology Advancement Advisory Committee (ETAAC) originally proposed a reduction of 0.8 million metric tons carbon dioxide equivalents (MMTCO2E) for this measure, with approximately 50% (0.4 MMTCO2E) being contributed by optimizing efficiency through adopting National Research Council (NRC) feeding guidelines and the remaining 50% through adopting digestive agents and long term breeding and management programs.[4] ETAAC also estimated that approximately 25 percent of the reductions, 0.2 MMTCO2E, could be achieved by 2020. However, feedback from stakeholders indicated that NRC guidelines are already widely adopted. Assuming half of dairy and cattle operations currently follow NRC guidelines, potential reductions achieved through adopting feeding guidelines is approximately 0.1 MMTCO2E in 2020.

Affected Entities

There are no affected entities associated with this measure other than owners of agricultural and livestock operations. However, adopting significantly different feedstocks for cattle and dairy cows could impact feed and forage industries and change fodder cropping patterns.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

Stakeholder Comments

This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email. Stakeholders showed interest in further research being conducted to improve the feed and cost efficiencies of this measure.

Environmental Justice Issues

The major environmental justice issue would be potential impacts on beef and milk prices if the costs of feeding ruminant agriculture increase significantly.

Small Business Impacts

No adverse impacts on small businesses are anticipated. This measure has the potential to create new small business markets for alternative feeds, and feed additives.

California Environmental Quality Act (CEQA Impacts)

Because this measure is not well-characterized at present, there are large uncertainties associated with how this measure may be implemented and the implementation outcomes. While the potential for increased VOCs and energy costs exists, it cannot be assessed or projected at this time.

Related Objectives

- The measure is motivated primarily by its greenhouse gas emissions reductions. Although other benefits may accrue, such as higher quality beef and milk products, and better cost

and feed efficiency, they are incidental to the primary objective.

Measure Metrics

- Information regarding the dairies or ranches which currently utilize NRC feeding guidelines, the associated herd sizes, and a method to track those that adopt NRC feeding guidelines in the future is needed to determine both program adoption and reductions in GHG emissions related to this program.
- Quantification methodologies that demonstrate the climate change benefits accrued overall and for each ranch or dairy adopting NRC feeding guidelines.

Measure Goals and Potential Implementation Approaches

By 2020, half of the ruminant agriculture operations who currently have not adopted recommended NRC feeding guidelines will do so. By 2050, the goal will be 100% achieved and all ruminant agricultural operators will have adopted NRC feeding guidelines.

Implementation Approaches

- Incentive Programs:
  - Provide technical assistance to ruminant agriculture to adopt the guidelines.
  - Offer financial incentives to manufacturers/producers of recommended feeds.
- Information Programs:
  - Provide NRC feeding guidance to the ruminant agricultural sector. NRC, UC Extension, Western Sustainable Agriculture Research and Education (SARE), County Agricultural Commissioners and the California Farm Bureau could play a role in developing and disseminating the information.

4. Technology

The National Research Council (NRC) has developed guidelines to optimize feed efficiency. Further technology is not required.

5. Statutory Status

The measure can be adopted with current authority.

6. Implementation Steps and Timeline

Implementation Steps

1. Compile technical guidance and related resources for adopting NRC feeding guidelines, including best management practice guides, directory of feed suppliers, record-keeping forms, etc.

2. Conduct outreach activities with the agricultural sector to describe the measure, the desired metrics, and disseminate resource materials.

3. Based on stakeholder feedback during outreach activities, assess the need for financial incentives.

4. Develop a reporting system and tracking database for capturing compost adoption metrics

5. Develop methods to quantify the avoided fugitive GHG emissions from landfills by adoption of composting technologies.

6. Using the measurement, reporting and tracking tools outlined in items 4 and 5, develop annual estimates of reduced GHG emissions from ruminant agriculture through adopting NRC feeding guidelines.

7. Greenhouse Gas Emission Reductions

By 2020, emissions of methane from ruminant agriculture could potentially reduce GHG emissions by 0.1 MMTCO2E per year.

8. Costs and Cost Savings

Costs for following NRC feeding guidelines are available, but time did not allow this section to be fully developed for this report. The presumed 50% of ruminant agriculture who currently follow NRC feeding guidelines can provide cost information. It is presumed that following NRC guidance may entail additional costs over other feeding programs.

Methodology:

NRC feeding guidance is established. Other costs and cost savings may be identified when this measure is more fully developed.

9. Other Benefits

There is a potential for greater feed efficiency, and higher quality beef and milk products to be realized.

10. References

1. US Department of Agriculture. Available at: http://www.usda.gov/wps/portal/usdahome

2. California Air Resources Board. *Final Report: Recommendations of the Economic and Technology Advancement Advisory Committee.* Feb. 11, 2008. Available at: http://www.arb.ca.gov/cc/etaac/ETAACFinalReport2-11-08.pdf

3. National Research Council. Available at: http://sites.nationalacademies.org/nrc/index.htm

4. California Department of Food and Agriculture. Available at: http://www.cdfa.ca.gov/

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Farmscape Sequestration (Planting Shrubs and Grasses in Hedgerows).

2. AgCAT Agencies:

California Department of Food and Agriculture, California Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. Measure Description

This measure calls for more research to determine if farmscape plantings have enough carbon sequestration potential to justify the design of protocols that would enable agricultural land owners to accurately quantify carbon sequestration.

Overview

Sequestering carbon in trees and other vegetation is a potential way to remove carbon dioxide (CO_2) from the atmosphere and lock it in woody biomass for a long period of time. Trees are relatively long-lived and biomass allometric equations exist for most California tree species, including riparian species, to assess biomass and growth. On the other hand, biomass allometric equations are not available for most woody shrubs, and such equations will be more difficult to develop than for trees. Assessing change in biomass over time may be a much more costly measurement per unit of carbon sequestered for shrubs than for trees. Also, shrubs tend to be much shorter-lived than trees and need to be constantly regenerated to ensure some permanence of the carbon sequestered in the woody biomass. Grasses do not have woody parts that perdure for many years and ensure some permanence of carbon sequestration. Some grasses develop extensive systems of roots that may (as they die and are replaced) cause an increase in soil organic carbon under the hedgerow. Assessment and time horizon of carbon sequestration in soils is discussed in another measure development.

For theses reasons, plantings of shrubs and grass in hedgerows are not included in this measure which discusses “riparian restoration and tree plantings on agricultural land,” despite the fact that they were lumped together in the EETAC report’s section 6.II.F.

Affected Entities

This measure will affect agricultural land owners that have an interest in farmscaping in general and in planting hedgerows consisting of shrubs and grasses.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

Stakeholder comments

This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email.

Environmental Justice

This measure will not have any adverse impacts on environmental justice communities.

Small Business Impact

No adverse impact is anticipated.

California Environmental Quality Act (CEQA) issues

No issues are foreseen.

Related Objectives

Related objectives include erosion control, reduced use of pesticides through integrated pest management, increased wildlife habitat, and increased corridors for wildlife movements through the landscape. These practices may also provide viewshed (or scenic) benefits for the public.

Measure Metrics

No metrics have been identified at this point.

Measure Goals and Potential Implementation Approaches

Goals in terms of GHG mitigation are unclear at this point. Research is needed on the carbon sequestration potential of farmscaping in California to determine whether farmscaping practices (and hedgerows in particular) have some potential to sequester significant amounts of carbon for the long term. If sufficient potential exists, rigorous quantification methodologies would need to be developed.

- Incentive Programs: At the federal level, the National Resources Conservation Service (NRCS) has incentive programs financed by the farm bill, such as the Conservation Reserve Program, the Environment Quality Incentives Program and the Wildlife Habitat Incentives Program, which provide incentive payments and cost-sharing to encourage producers to implement farmscaping practices. The US Fish and Wildlife Service has a program called Partners for Wildlife that emphasizes the reestablishment of native vegetation and ecological communities for the benefit of fish and wildlife in concert with the needs and desires of private landowners.
- Offsets Program: Protocols for carbon sequestration projects through planting and managing hedgerows of grasses and shrubs cannot be developed without further research.
- Research: Applied research should be supported to assess the potential of farmscaping practices (and hedgerows in particular) to sequester significant amounts of carbon for the long term. And if so, what measurements would be practical to ascertain the sequestration and to sustain the development of specific protocols.

4. Technology

No new technologies are needed to implement this measure.

5. Statutory Status

No statutory modifications are needed to implement this measure.

6. Implementation Steps and Timeline

To be determined.

7. Greenhouse Gas Emission Reductions

More information is needed.

8. Costs and Cost Savings

More information is needed.

9. Other Benefits

See “related objectives” above. A special study would have to be conducted to be more specific.

10. References

ETAAC, 2008. Recommendation of the Economic and Technology Advancement and Advisory Committee (ETAAC) on Technologies and Policies to Consider for Reducing Greenhouse Gas Emissions in California. February 14, 2008. Available at: http://www.arb.ca.gov/cc/etaac/ETAACFinalReport2-11-08.pdf

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Manure Digester Protocol

2. AgCAT Agencies:

California Department of Food and Agriculture, California Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. Measure Description

Overview

California is home to about 1,800 dairies with over 1.7 million dairy cows. The resulting manure is a significant source of methane that can be emitted to the atmosphere or captured and used for heat and/or energy. Manure digesters (digesters; also called biogas control systems) are systems which trap gaseous emissions from manure (primarily methane) and combust the gas. The trapping process is achieved by enclosing the manure, which often involves covering a manure lagoon with plastic or otherwise isolating the manure from the ambient environment. The combustion process occurs either by combusting the trapped methane biogas in an engine in order to generate electricity, or by venting and flaring the gases. Methane captured through the installation and use of an anaerobic digester can be used for electric power production, for heat, as an alternative to natural gas in combustion, or as a transportation fuel.

The Livestock Protocol developed and approved by the California Climate Action Registry (CCAR) provides methodologies for calculating reductions in the emissions of GHGs resulting from the installation and operation of a manure digester at an animal livestock facility. Although this protocol was adopted by CCAR, adoption by the Air Resources Board (ARB) would send a clear signal that ARB considers the protocols to be accurate and acceptable for voluntary GHG emissions reductions. ARB is initiating a process to continue discussions on the protocol by holding workshops to solicit comments on the protocol and to identify potential protocol improvements. The ultimate goal is to present the protocol to our Board for adoption as a voluntary GHG reduction measure.

Establishing a voluntary protocol can help incentivize the installation of manure digesters by legitimizing the technology and offering a pathway to quantify and verify the GHG benefits. Keeping this protocol a voluntary measure helps avoid premature technology mandates which could have significant cost and environmental drawbacks due to digesters currently being a costly, combustion-driven technology.

Affected Entities

1) Board adoption of the CCAR Livestock Protocol will affect farmers or dairies that currently operate or plan to adopt manure digester technologies. Currently, less than one percent of dairy manure is processed in digesters in California.
2) Energy companies/agencies responsible for implementing energy policy, pricing and funding.
3) California regulatory agencies involved in various aspects of permitting digesters including the Local Air Pollution Control Districts, Regional Water Quality Control Boards and the California Integrated Waste Management Board.
4) Adoption of the CCAR Livestock will also affect any organizations involved in mitigating GHGs such as AgCert, the Center for Energy Efficiency and Renewable Technology (CEERT), etc., if additional GHG reduction projects require certification/verification.

Environmental Justice, Small Business, Public Health, Leakage and the California Environmental Quality Act (CEQA)

This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report.

In addition, CCAR began developing a protocol for calculating manure greenhouse gas emission in April 2006. The protocol development process began with a scoping meeting, included multiple working group meetings and document reviews, and included representatives from nearly every stakeholder group, including industry, government, academia, and the general public. ARB held several public workshops on the Livestock Protocol in 2007 and 2008 with the goal of presenting the protocol to the Board by the end of 2008.

ARB staff has proposed to evaluate all practices and technologies associated with manure management strategies to ensure that efforts to achieve and maintain federal and state ambient air quality standards and to reduce toxic air contaminant emissions are not compromised. This complies with the “no backsliding” provision of Assembly Bill 32 (AB 32). ARB staff also proposes to evaluate potential manure management GHG emission reduction strategy, to maximize resource recovery, comply with water quality regulations, preserve environmental justice, and minimize adverse impacts on small business, particularly in the agricultural community.

Related Objectives

The measure is motivated primarily by its greenhouse gas emissions reductions.

Measure Metrics

Metrics for manure management strategies have not yet been developed, but could include the following for all confined animal facilities (CAFs) in the state, per facility, or per animal unit 1) the total production of manure; 2) the total reduction in GHGs (in million metric tons of carbon dioxide equivalents; $MMTCO_2E$); 3) the total usable (expressed in British thermal units (Btu)

content) methane gas produced (in standard cubic feet); 4) the total amount of electricity (kilowatts, (kw)) produced; and 5) the total production of usable residues (in lb).

4. Technology

Identify and evaluate various practices and technologies that could be employed at CAFs:

1) Reduce uncontrolled methane emissions by maximizing aerobic conditions as manure is collected from animal containment areas, transferred and processed by liquid/solid separators, and contained, treated, and stored in lagoons (liquid fraction) or compost piles (solid fraction);
2) Optimize the production of methane by maximizing anaerobic conditions of digesters on lagoons that store the separated liquids;
3) Optimize resource recovery by collecting and cleaning digester gas for use in on-site heat and power applications; introducing cleaned gas into a transmission system; and/or providing excess electricity to utilities;
4) Optimize resource recovery by drying the solid manure fraction prior to converting the methane to electricity, gas, and liquid fuels; and
5) Maximize the on-site use and off-site sale of residuals (soil amendments, animal bedding) that remain after 1) through 4) above.

5. Statutory Status

Chapter 479, Statutes of 2003 (SB700, Florez) made agricultural sources subject to permitting and specified emission mitigation requirements for criteria pollutants. The local air districts are in the process of evaluating emission reduction options. However, their evaluation does not specifically address GHGs. AB 32 requires that ARB develop GHG reduction strategies that do not interfere with existing air pollution control measures.

6. Implementation Steps and Timeline

- Present the CCAR manure digester protocol for Board adoption in the fall of 2008.
- Continue to compile technical and cost information for digester technologies and on-going policy development for using captured methane for heat and power, and to disseminate this information to stakeholders, 2008 – 2013.
- Continue to meet with stakeholders to discuss and receive comments on the evolving technologies and policies, 2008 – 2013.
- Re-assess the voluntary status of adopting manure digester technologies per ARB's Scoping Plan, 2013.

Measure Goals and Potential Implementation Approaches

Due to the costs involved with installing and operating manure digesters (minimum average capital costs to install a digester at a 1,000 head dairy are approximately $1.2 million), effective implementation of this measure will most likely require add regulatory and financial support.

Incentive Programs: Wider adoption of digesters could be encouraged by: tariffs, accelerating the Renewable Portfolio Standard, establishing renewable energy credits and emission reduction credits, increasing the biogas net metering credit and/or eliminating the net metering

cap, and providing the same incentives for biogas-fueled technologies as currently exist for other forms of renewable energy.

Offsets Program: Reductions achieved through implementation of this measure could provide a source of offsets for sectors that may need offsets to help contain costs or meet a mandatory cap.

Information Programs: Limited information on the technical, economic and environmental impacts of manure digester systems hinders wider adoption of digester technologies. Ideally, along with developing cost estimates for the various digester technologies, information would be developed to match the characteristics of specific dairy farms such as herd size, type of manure handling system used, power generation potential, and other related variable, with the most appropriate technologies.

7. Greenhouse Gas Emission Reductions

Greenhouse Gas Emission Effects:

ARB's 2004 emissions inventory indicates that GHG emissions from manure management totaled 6.91 million metric tons of carbon dioxide equivalents ($MMTCO_2E$). These emissions accounted for 29.7 percent of agriculture-related GHG emissions in California and 1.4 percent of the total GHG emissions in California. While the proposed technologies and practices reduce GHG emissions, their exact control efficiencies have not been determined. ARB staff estimates that a potential reduction of 1 $MMTCO_2E$ could be achieved by 2020, representing a 15 percent reduction in 2004 GHG emission levels.

8. Costs and Cost Savings

Costs and Cost Savings:

The cost of manure digesters includes the cost of systems to capture the methane, including purchase and installation of the system components, permitting, and operation and maintenance costs; the costs of using captured methane to generate heat, electrical power, biogas and/or biofuels; the costs associated with utility and/or gas biogas transmission contracts, including interconnection costs; and the cost of transporting solid manure by-products off-site. The cost savings include avoided on-site heat, utility and/or fuels costs, avoided synthetic fertilizer costs, avoided costs of animal bedding and/or potential income from sales of solid manure by-products. It is estimated that installing a digester at a large dairy (over 1,000 head) costs upwards of $1.2 million. Currently, estimates are not available for the other costs because the technology has not been widely adopted in California (approximately 22 digesters are currently in operation, 13 of which were established only in the past 5 years) and because each current system is unique in the both type of funding used to install the digester and in the utility contracts secured.

9. Other Benefits

Manure digester and technologies minimize the formation of GHGs and/or maximize energy and nutrient resource recovery from collected manure. In addition, potential co-benefits including improved animal health and living conditions, reduced impacts on groundwater, reduced use of synthetic fertilizers, reduced emissions of hydrogen sulfide and ammonia, and improved nuisance control, such as flies and odor may be realized.

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California Department of Food and Agriculture, California Agricultural Resource Directory, 2006.
Available at: http://www.cdfa.ca.gov/files/pdf/card/AgResDirEntire06.pdf

Dairy Permitting Advisory Group, Recommendations to the San Joaquin Valley Air Pollution Control Officer Regarding Best Available Control Technology for Dairies in the San Joaquin Valley Final Report, January 31, 2006.
Available at: http://www.valleyair.org/busind/pto/dpag/Final%20DPAG%20BACT%20Rep%201-31-06.pdf

San Joaquin Valley Dairy Manure Technology Feasibility Assessment Panel, An Assessment of Technologies for Management and Treatment of Dairy Manure in California's San Joaquin Valley, December 2005.
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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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Outline

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. *Measure: Collaborative Research to Understand How to Reduce Nitrous Oxide Emissions from Nitrogen Land Applications*

2. *AgCAT Agencies*:

California Department of Food and Agriculture, California Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. *Measure Description*

Overview

Nitrous oxide, or N_2O, is a greenhouse gas (GHG) with a Global Warming Potential (GWP) of 298 (International Panel on Climate Change, (IPCC), 2007). N_2O contributes roughly 15.6 million metric tons of carbon dioxide equivalents ($MMTCO_2E$), or 2.8% of the total GHG inventory of California in 2004 (CARB, 2007). Agricultural soil is considered the largest source of N_2O emissions in California, contributing probably more than 50% of total N_2O, primarily derived from nitrogen rich substances such as plant residues, manure amendments, and nitrogen fertilizers. Because N_2O is generated through microbiological processes of nitrification and denitrification in soil as part of the natural nitrogen cycling, its emission is closely related to the amount of nitrogen compounds in the soil. Limiting input of nitrogen sources into the agricultural ecosystems by improving nitrogen application efficiency or plant uptake is therefore the key to mitigating N_2O emissions from the soil. In addition, alternative agricultural management practices that affect physical, chemical, and biological properties of the soil environment, and consequently soil microbial activities would also offer opportunities to mitigate N_2O emissions.

Application of nitrogen fertilizers is an essential element of modern agriculture which supports a world population of more than 6.6 billion today. To maintain agricultural productivity while minimizing nitrogen inputs, we must increase nitrogen application efficiency, which is only about 30 to 50% currently (Tilman et al., 2002). For example, according to IPCC (1997; 2006), on average approximately 50% of the nitrogen fertilizer applied in the field is lost to the transport pathways of volatilization, leaching, and runoff. Best management practices (BMPs) that reduce nitrogen losses, prolong nitrogen residence time in soil, and benefit crop uptake need to be identified and implemented. Because California agriculture is highly dynamic with respect to crop, soil, and climatic

conditions, no universal management rules are robust enough to guarantee efficiency and GHG reductions.

This measure seeks collaborative research with stakeholders to better assess nitrogen fate and its regulating factors in agricultural ecosystems under California-specific conditions, and identify BMPs that would increase nitrogen application efficiency and thereby reduce N_2O emissions. State agencies including ARB, CEC and CDFA have consulted with State experts and other stakeholders to identify preliminary data gaps and research areas in nitrogen management, and will be coordinating with the stakeholders to prioritize our research activities. The outcome of this focused research is expected to inform subsequent work that will lead to specific N_2O emission reduction strategies.

Affected Entities

This measure would affect growers and farming land owners directly and nitrogen fertilizer manufacturers indirectly.

Environmental Justice, Small Business, Public Health, Leakage and CEQA

This measure was adopted as one of ARB's Early Action Items and was discussed by the Agriculture Climate Action Team Subgroup. The measure was also evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report.

As part of ARB's Early Action process, the measure was discussed in public workshops/symposia. For Scoping Plan development, ARB staff conducted two public workshops during which the concept of this measure was presented, along with other agriculture related strategies. These meetings offered opportunities for stakeholders to provide inputs on potential strategies for GHG reductions within the agricultural sector. In addition, staff has sought comments from the San Joaquin Valley Agriculture Technical Group (AgTech) on the research concepts received at ARB for the 2009-10 Research Plan. The AgTech consists of representatives from diversified communities including CARB, CDPR, San Joaquin Air Pollution Control District, commodity groups, academics, and other interested stakeholders.

The measure has no impacts on environmental justice communities, public health, or small business at this stage of research development. The research activities pursued under this measure are not required to address California Environmental Quality Act (CEQA) elements. No issues of GHG leakage are of concern with regard to the research activities.

Related Objectives

The measure is motivated primarily by its GHG emissions reduction potential. Although the initial research activities would not generate any reductions, they are expected to inform identification of specific BMPs that would reduce inputs of nitrogen sources (such

as chemical fertilizers) into agricultural ecosystems, and therefore the release of other pollutants (such as ammonium, nitrate and nitrite) derived from these sources.

Measure Metrics

The primary metrics that can be used to track and benchmark the progress and success of the research effort are:

1) Establishing baseline emissions;
2) The number of BMPs that have been tested and ascertained by the research projects; and
3) The total acreage of the crop land covered by the BMPs in terms of their applicability with respect to the type of crops, soil properties, and climatic conditions.

The ultimate reduction of GHGs, however, would depend upon the adoption of BMPs once they are identified.

Measure Goals and Potential Implementation Approaches

The primary goals of this measure are to improve understanding of nitrogen cycling and regulating factors with regard to nitrogen management in California agriculture ecosystems; to identify opportunities/deficiencies in current agricultural production practices; and to eventually provide directions for BMP guideline development. The ultimate goal of this measure is to reduce synthetic nitrogen fertilizer use in California agriculture by enhancing nitrogen application efficiency through voluntary adoption of the BMPs.

Implementation of collaborative research on nitrogen management necessitates open communication channels between State agencies and with stakeholders. ARB, CDFA and CEC have agreed to coordinate and prioritize research programs addressing nitrogen management in California's agricultural sector with input from interested stakeholders.

4. Technology

Currently, it is unknown what technologies or N_2O mitigation strategies for agricultural soil management are effective. These will be identified through looking at past and forthcoming research. A number of mitigation measures for N_2O reduction from agricultural soil management were proposed by stakeholders during the public sessions of the Climate Action Team Report and Early Action development. The mitigation potential of these measures should be carefully examined under California specific conditions and from a Lifecycle Analysis perspective. Such an assessment should consider both reductions of N_2O, and other GHG emissions.

5. Statutory Status

The measure can be implemented under the statutory authority of AB 32. No statutory modification is needed.

6. Implementation Steps and Timeline

Due to the extremely tight timeline of the AB 32 mandates, we recommend that CARB start developing BMP guidelines for nitrogen management based on existing information and data. Much nitrogen research has focused on increasing nitrogen efficiency, which helps reduce N_2O emissions. CARB should work with the State nitrogen experts, such as County Farm Advisors and Cooperative Extension Specialists in the University of California system, to evaluate existing BMPs and develop BMP guidelines concurrently with the research process.

7. Greenhouse Gas Emission Reductions

The initial research activities sought under this measure are not expected to yield reductions. However, this research effort is expected to inform subsequent work that will lead to development of specific emission reduction strategies or BMPs.

8. Costs and Cost Savings

Research is the primary focus of this strategy. Due to the extreme diversity of California's agricultural portfolio, the research funds required could be in the range of several millions over the next few years. This research effort will require extensive technical and financial collaboration with industry and other government agencies. The cost for implementing any of the potential BMPs at a later phase can only be assessed once specific measures are identified from the collaboration research activities and a comprehensive in-depth review of existing information.

9. Other Benefits

Although the research activities would not generate any immediate reductions, they are expected to lead to identification of management practices that would reduce nitrogen fertilizer use. Nitrogen fertilizers are sources of many environmental pollutants such as nitrate and nitrite in water resources and ammonium, a precursor for the criteria pollutant $PM_{2.5}$. The co-benefits of the research effort will be quantified when specific strategies are pursued as directed by the future collaboration research activities.

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Intergovernmental Panel on Climate Change (IPCC). 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). ISBN 4-88788-032-4, Published: IGES, Japan.

Intergovernmental Panel on Climate Change (IPCC). 2007. IPCC Fourth Assessment Report: Climate Change 2007. Working Group I Report “The Physical Science Basis”. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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Outline

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Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

1. Measure: Riparian Restoration and tree planting on agricultural lands.

2. AgCat Agencies:

California Department of Food and Agriculture, California Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission.

It is suggested that the California Department of Forestry and the California Department of Conservation should also be involved with this measure due to their responsibilities related to forestry and open land preservation and management.

3. Measure Description

This measure explores the potential for agricultural land owners to sequester additional carbon through tree planting and restoration of riparian areas. These activities could be integrated into existing quantification efforts. This would be most efficiently achieved by including riparian restoration and hardwood rangeland regeneration efforts in general forestry protocols and by including tree plantings in rows (e.g. windbreaks) in the urban forestry protocols being developed.

Overview

Sequestering carbon in trees is a potential way to remove carbon dioxide (CO_2) from the atmosphere and lock it in woody biomass for a long period of time. Trees are relatively long-lived and biomass allometric equations exist for most California tree species including riparian species to assess biomass and growth. On the other hand, biomass allometric equations are not available for most woody shrubs, and such equations will be more difficult to develop than for trees. Assessing change in biomass over time may be a much more costly measurement per unit of carbon sequestered for shrubs that for trees. Also, shrubs tend to be much shorter-lived than trees and need to be constantly regenerated to ensure some permanence of the carbon sequestered in the woody biomass. Plantings of shrubs and grass in hedgerows are not included in this measure despite the fact that they were lumped together with tree plantings in the ETAAC report's section 6.II.F.

A large proportion of California's agricultural lands did not support trees before conversion to agriculture. However, riparian forests were cleared for agriculture in many parts of the state and some of that land may be restored with tree plantings and appropriate management. Also, many of California's rangelands are hardwood woodlands or savannas that have been suffering from a lack of regeneration (i.e. no young trees for replacement). Adapted management and tree plantings could help maintain and possibly increase tree density on hardwood rangelands in the long run. Finally, even on land that never supported trees, growing large trees for windbreaks can be achieved with enough irrigation.

Tree growth and woody biomass accumulation will vary greatly depending on species and environment. Trees grow at a faster rate in (wet) riparian settings than in (dry) rangeland

conditions. The cost of establishing trees along rivers and sloughs is likely to be lower because of relatively easy access to a water table. Where irrigation is required for establishment and possibly for maintenance, costs will be higher.

Affected Entities

This measure will affect agricultural land owners that have an interest in riparian restoration, hardwood rangelands regeneration or tree plantings. The extent of participation is unknown at this point. The establishment of market mechanisms allowing for use of offsets may be needed to encourage these activities. However, due to the costs involved, it is anticipated that the value of offsets for these projects may not cover the costs of plantings and management; especially in settings were additional maintenance costs are necessary to nurse the young trees, such as irrigation, protection from cattle and wild browsers, etc. The combination of an offset program with incentives from other state or federal conservation programs may help convince a greater number of land owners to proceed with the practices described in this measure.

Environmental Justice, Small Business, Public Health, Leakage and the California Environmental Quality Act (CEQA)

Stakeholder comments

This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email.

Environment justice issues

This measure will not have any adverse impacts on environmental justice communities.

Small Business Impact

No adverse impact is anticipated. The measure may provide increased business opportunities for restoration specialists and native plant nurseries.

CEQA issues

The implementation of riparian restoration and hardwood rangeland regeneration projects entails a long term commitment. To ensure carbon sequestration over the long term, these riparian and woodland projects would require permanent retirement of development rights, preclude uses that would reduce carbon stocks or sequestration capacity, and prescribe management geared toward maintaining or increasing carbon sequestration. CEQA benefits may incur by excluding these lands from development.

Related Objectives

Related objectives include erosion control, reduction of sedimentation of watersheds, water quality (riparian buffering of nutrient inputs to rivers) and wildlife habitat. Since these projects would occur on private land, they would not increase recreational opportunities, but they may provide viewshed (or scenic) benefits for the public.

Measure Metrics

Metrics for adoption of this measure would include the following: the number of land owners that are undertaking projects, the number of acres of riparian forest restored, or acres of hardwood rangelands with ensured regeneration, or miles of continuous windbreaks planted. Tree densities, mature size and growth rates will be very variable though, and areal or length

measurements will not be reliably translated into amounts of CO_2 removed from the atmosphere or C sequestered.

The metric for GHG mitigation must be the number of tonnes of carbon offsets/credits sold and independently verified through adapted forestry protocols (and the corresponding tonnes of CO_2 equivalent).

Measure Goals and Potential Implementation Approaches

The goal for this measure is unclear at this point. The final ETAAC report estimated that 2.9 million tonnes of CO_2 equivalent may be sequestered "*assuming 500,000 acres on the edges of cropland and rangeland might be available for re-vegetation or farmscaping with woody shrubs and trees and that annual carbon storage over the initial 20 years of vegetation growth amounts to 5.8MTCO$_2$E per acre.*" Unfortunately, since the authors of the ETAAC report did not document the basis for their assumptions, this goal is currently unsubstantiated.

Another problem with defining this goal is that it may involve some double-counting with those cited by the "Forest Conservation strategy" element of the scoping plan that also discusses riparian forest and hardwood rangelands. Thus, a unified strategy should be implemented for such reforestation and tree planting efforts.

- Incentive Programs: At the federal level, the National Resources Conservation Service (NRCS) has incentive programs financed by the farm bill, such as the Environment Quality Incentives Program and Wildlife Habitat Incentives Program, which are compatible in their goals with the management actions discussed for this measure. These programs provide incentive payments for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive. Such incentives combined with longer-term carbon sequestration credits may work together to incentivize some land-owners to proceed. Federal legislation that would explicitly add the goal of carbon sequestration to such programs could help guarantee that such synergy continues to exist in the long-term. At the state level, incentives to set up agricultural or conservation easements to guarantee the long term sequestration of the carbon must be maintained and reinforced through tax measures or other means.
- Offsets Program: Management practices to restore riparian forests, create new riparian buffers, or increase tree densities and regeneration in hardwood rangelands are not specific to a particular type of land ownership. Protocols for carbon sequestration projects through planting and managing stands of trees have already been developed (e.g. afforestation, conservation forestry protocols). These forestry protocols should be used (with possible adaptations) to define such projects and to calculate and verify carbon credits. Likewise, planting and tending trees in single rows on farm land (as wind breaks or as part of a hedge) is similar to planting and tending trees along a boulevard and should be included with urban forest protocols as they are developed.
- Research: Applied research should be supported to refine management practices that reduce establishment costs and maximize carbon sequestration for the long-term.
- Information Programs: Outreach and information should be supported through existing conduits such as University Extension Services and Resources Conservation Districts.

4. Technology

No new technologies are needed to implement this measure.

5. Statutory Status

No statutory modifications are needed to implement this measure.

6. Implementation Steps and Timeline

Although there is potential to sequester some carbon with this measure, the potential amount is unclear at this point. One aspect that needs to be addressed before estimating the carbon sequestration potential through this measure is ensuring that there is no double-counting between activities described in this measure with potential sequestration activities evaluated by the "Forest Conservation strategy" element of the scoping plan that also discusses riparian forest and hardwood rangelands.

A unified strategy should be implemented for such reforestation and tree planting efforts. Also, experts should be consulted to substantiate potential C sequestration estimates.

7. Greenhouse Gas Emission Reductions

More information is needed.

8. Costs and Cost Savings

More information is needed.

9. Other Benefits

See "related objectives" above. A special study would have to be conducted to be more specific.

10. References

ETAAC, 2008. Recommendation of the Economic and Technology Advancement and Advisory Committee (ETAAC) on Technologies and Policies to Consider for Reducing Greenhouse Gas Emissions in California. February 14, 2008

Climate Action Team
Sector Sub Group
Scoping Plan Measure Development and Cost Analysis

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Outline

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Air Resources Board
Scoping Plan Measure Development and Cost Analysis

1. Measure: Agricultural Equipment Efficiency Improvements-- Tractor Tire Inflation Program

2. AgCAT Agencies:

California Department of Food and Agriculture, California Air Resources Board, California Energy Commission, California Integrated Waste Management Board, California Department of Pesticide Regulation, Department of Water Resources, State Water Resources Control Board, Regional Water Quality Control Board, California Environmental Protection Agency, Department of Conservation, Department of Toxic Substance Control, California Public Utility Commission

3. Measure Description

This measure explores the potential for implementing an education and outreach program on the benefits of maintaining correct/low tractor tire pressures in farming operations. This is not a regulatory measure. It is an information sharing strategy for implementing voluntary actions with the potential to further a number of State policy objectives including the reduction of criteria pollutant emissions and GHG emissions.

Overview

The Agricultural Engineering Department at the University of California Davis conducted a study on the effects of correct/low inflation pressure for radial ply tractor tires as compared to over inflated tractor tires during primary tillage operations employed in the production of processing tomatoes, rice and cotton. Results from the study show that correct inflation pressures for radial ply tires based on the tire load can result in significant fuel savings, increased productivity, and reduced soil compaction. A tractor using low/correct tire pressure required approximately 20 percent less diesel fuel and increased productivity by 5-10 percent.

Measures taken to insure low/correct tire pressure can result in cost savings for framers from reduced fuel usage, and increased productivity while also reducing GHG and criteria pollutant emissions resulting from diesel fuel combustion. In addition, soil compaction created by tractor traffic may also create favorable conditions for N_2O production in soil due to its effect on soil aeration, proper tire inflation can reduce this effect, however N2O effects have not been adequately quantified.

This measure includes the development of best practice protocols for insuring proper tractor tire inflation and an education and outreach program to promote GHG reductions. A guide, such as the guide put out by the California Energy Commission, *How to Get the Most from Radial Ply Tractor Tires, a Guide to Selecting the Correct Inflation Pressure*, would be disseminated though agency education and outreach efforts, Agricultural Commissioner's Offices during permit renewal, and by distributors of tractor tires and provided to the farmer at the time of sale.

Affected Entities

A tractor tire program measure will affect:

1) Agricultural operations which utilize tractor equipment
2) Agency implementing program

Environmental Justice, Small Business, Public Health, Leakage and CEQA

This measure was identified by the Agriculture Climate Action Team Subgroup and was evaluated in detail in the Environmental and Technology Advancement Advisory Committee (ETAAC) report, and as part of the AB 32 Agriculture Sector Work Group. ARB staff accepted comments on strategies and measures presented at workgroup meetings and comments submitted online or by email.

This measure does not interfere with public health efforts such as achieving and maintaining federal and State air quality standards and reducing toxic emissions. Successful implementation of the measure should reduce toxic and criteria pollutant emissions resulting from diesel fuel combustion.

There should be no effect on small business from implementation of this measure.

Related Objectives

This measure is motivated by both greenhouse gas emission reduction objectives as well as reductions in criteria pollutants, toxics and potentially significant cost savings for farmers. In addition, the measure may reduce soil compaction and extend tire life.

Measure Metrics

Gallons of fuel savings per acre.

Annual harvested acreage of processing tomato, rice and cotton.

Training and outreach program penetration, estimated 10 percent per year starting in 2010.

Measure Goals and Potential Implementation Approaches

The goal of this measure is to provide information to the agricultural sector, particularly those employing the use of tractors for primary tillage or other on-farm operations, on the benefits associated with correct/low tractor tire inflation. A guide, such as the guide put out by the California Energy Commission, *How to Get the Most from Radial Ply Tractor Tires, a Guide to Selecting the Correct Inflation Pressure*, could be disseminated though agency education and outreach efforts, Agricultural Commissioner's Offices during permit renewal, and by distributors of tractor tires and provided to the farmer at the time of sale.

4. Technology

Direct or indirect tire pressure monitoring systems are now required to be installed in passenger cars, trucks, multipurpose passenger vehicles, and buses with a gross vehicle weight rating of 10,000 pounds or less. While not required for implementation of an education and outreach effort, similar systems which take into account load characteristics could be implemented on farm tractor equipment could aid farmers in insuring correct tractor tire pressure. ARB staff should work with manufactures to determine the ability to make such systems standard tractor equipment. Staff could also explore potential incentive mechanisms for the purchase and instillation of tire pressure monitoring systems for existing equipment.

5. Statutory Status

No statutory modifications are needed to implement this measure.

6. Implementation Steps and Timeline

1. Update and refine CEC's existing tractor tire pressure guide.

2. Disseminate guide through agency education and outreach efforts, Agricultural Commissioner's Offices during permit renewal, and by distributors of tractor tires and provided to the farmer at the time of sale.

3. Goal of achieving 10 percent program penetration and implementation each year to 2020.

4. Identify effective tractor tire pressure monitoring systems which account for load characteristics and work with tractor manufactures to determine the ability to make systems standard tractor equipment.

7. Greenhouse Gas Emission Reductions

Greenhouse Gas Emission Effects:

This measure is an education and outreach measure, the extent of actual implementation is unknown. Assuming most processing tomato, rice and cotton farmers conduct primary tillage operations using overinflated tires and implement actions to ensure low/correct tractor tire pressures, we would expect an estimated 1,855,000 gallons of diesel fuel saved per year or 19,000 tons of CO_2 reduction per year. Because many other crops are grown in California (processing tomato, rice and cotton account for approximately 1.5 million acres out of nearly 10 million acres in 2005[1]), and tractors are used in many on-farm operations not related to primary tillage, actual fuel savings and the resulting greenhouse gas and criteria pollutant reductions could be several times higher than this estimate. Using the assumptions listed below at 100 percent implementation of this measure, a statewide total of 13,600,000 gallons of fuel could be saved, which is equivalent to 0.14 MMT CO2E.

Assumptions:

[1] California Statistical Abstracts, 2006

- Average fuel savings per acre for primary tillage operations in processing tomato, rice and cotton ($1.36/acre) is representative of fuel savings for other crops in California.
- Primary tillage or similar operations are employed for all crops and all acreage in California.
- Farmers conduct primary tillage operations using overinflated tires and implement actions to ensure low/correct tractor tire pressures.
- Total California farm acreage remains comparable to 2005 acreage.

Due to the nature of voluntary nature of this measure with an education and outreach implementation mechanism, it is unreasonable to expect 100 percent implementation for primary tillage operations. However, implementation of practices to ensure correct/low tire inflation will most likely be carried over to other on-farm operations potentially offsetting any missed opportunities from primary tillage operations.

Methodology:

Calculations for fuel savings due to correct/low tire pressures were obtained from CEC's Guide *How to Get the Most from Radial Ply Tractor Tires, a Guide to Selecting the Correct Inflation Pressure.* These figures were based on a study conducted by the Agricultural Engineering Department at the University of California Davis on the effects of correct/low inflation pressure for radial ply tractor tires as compared to over inflated tractor tires during primary tillage operations.[2] To determine the fuel savings associated with using correct/low tire pressure, fuel used with over inflated tractor tires (24 psi) were compared to tractor tires adjusted to correct/low inflation based on axel load for each tillage operation to obtain gallons of fuel saved per acre.

Fuel savings calculations were then applied to data on the estimated fuel costs per acre of three primary tillage operations employed in producing processing tomatoes, rice and cotton in California.[3]

Fuel savings per acre for each crop were multiplied by the total harvested acreage for processing tomatoes, rice and cotton to obtain a statewide annual fuel savings potential for each. For this calculation, CEC's report used harvested acreage for 1993. Acreage information was updated with 2005 for calculations.

Average fuel savings per acre for primary tillage operations in processing tomato, rice and cotton were used to calculate potential fuel savings for all harvested acreage (2005) in California.

8. Costs and Cost Savings

Costs and Cost Savings:

[2] Lancas, K.P., S.K. Upadhyaya, and M. Sime. 1994. Traction and soil compaction due to low pressure tires. Unpublished report. Agricultural Engineering Department, University of California Davis

[3] STRANGE, M. et al. 1992. Sample costs to produce processing tomatoes in the San Joaquin valley. UC Cooperative Extension, University of California.

[3] WILLIANS, J. et al. 1992. Sample cost to produce rice. UC Cooperative Extension, University of California.

[3] KERBY, T. et al. 1992. Sample costs to produce 40 inch row cotton in the San Joaquin valley. UC Cooperative Extension, University of California.

There are no costs to the farmers associated with an education and outreach program for Tractor Tire Inflation. The only cost would be programmatic costs of the implementing agency.

The cost savings associated with a Tractor Tire Inflation Program include the fuel savings, decreased labor costs due to increased productivity and any resulting increase in tire life.

Diesel fuel savings could be up to 13,600,000 gallons per year.

There are also cost savings associated with a 5 to 8 percent increase in productivity.

9. Other Benefits

Reduced fuel usage associated with implementation of this measure would result in reductions of criteria pollutants associated with combustion of diesel fuel.

10. Summary Table

11. References

[1] California Statistical Abstracts, 2006
[2] Overinflated tractor tires waste fuel, reduce productivity. *Kleber P. Lancas, Shrini K. Upadhyaya, Muluneh Sime and Sayedahmad Shafii* California Agriculture March-April 1996

[3] STRANGE, M. et al. 1992. Sample costs to produce processing tomatoes in the San Joaquin valley. UC Cooperative Extension, University of California.
[3] WILLIANS, J. et al. 1992. Sample cost to produce rice. UC Cooperative Extension, University of California.
[3] KERBY, T. et al. 1992. Sample costs to produce 40 inch row cotton in the San Joaquin Valley. UC Cooperative Extension, University of California